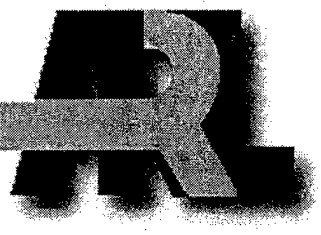
ARMY RESEARCH LABORATORY



Abbreviated Assessment of Three Moving Map Displays for the UH-60 Helicopter

David B. Durbin
Richard N. Armstrong

ARL-TN-174 DECEMBER 2000

The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

Citation of manufacturer's or trade names does not constitute an official endorsement or approval of the use thereof.

Destroy this report when it is no longer needed. Do not return it to the originator.

Army Research Laboratory
Aberdeen Proving Ground, MD 21005-5425

ARL-TN-174 December 2000

Abbreviated Assessment of Three Moving Map Displays for the UH-60 Helicopter

David B. Durbin
Richard N. Armstrong
Human Research & Engineering Directorate

Abstract

An assessment of three moving map display systems was conducted to support modernization of the UH-60 helicopter. The systems included the Peregrine digital map, Appliqué V2 computer and Force XXI Battle Command–Brigade and Below (FBCB2) software, and the Primary Selectable Mission Support System (PRISMS2). The assessment was based on subjective ratings by Army pilots regarding the impact of the moving map displays on aircrew workload and situational awareness when these displays are used in the cockpit for pilotage, navigation, and mission tasks. The pilots also assessed the hardware and software usability characteristics of the displays. Results indicate that each system has potential for enhancing situational awareness and minimizing workload for UH-60 pilots. However, significant improvements in the hardware and software interface of the Appliqué-FBCB2 and Peregrine digital map would need to occur before they would be suitable for use in the UH-60 cockpit. Improvements in the hardware and software interface of the PRISMS2 would enhance its usability in the cockpit. Each of the systems would also need to be fully interoperable with the Aviation Mission Planning System.

Contents

Figures

Tables

Executive Summary

The Army is planning to modernize the UH-60 helicopter. Because it will take several years to modernize the UH-60 fleet, the Program Manager (PM) for Utility Helicopters is exploring the potential of existing systems and technologies to provide a near-term solution for digitizing the aircraft. To assist the PM in this effort, an abbreviated assessment was conducted of three moving map display systems that could be used as part of the near-term solution for digitizing the UH-60. The systems included the Peregrine digital map, Appliqué V2 computer and Force XXI Battle Command–Brigade and Below (FBCB2) software, and the Primary Selectable Mission Support System (PRISMS2). The assessment was based on subjective ratings by Army pilots regarding the impact of the moving map displays on aircrew workload and situational awareness when these displays are used in the cockpit for several pilotage, navigation, and mission tasks. The pilots also assessed the hardware and software usability characteristics of the displays. The results indicate that using the Peregrine digital map, Appliqué-FBCB2, or PRISMS2 in the UH-60 cockpit has potential for enhancing aircrew performance of pilotage, navigation, and mission tasks. However, significant improvements in the hardware and software interface of the Appliqué-FBCB2 and Peregrine digital map would need to occur before they would be suitable for use in the UH-60 cockpit. Improvements in the hardware and software interface of PRISMS2 would enhance its usability in the cockpit. Interoperability with the Aviation Mission Planning System would also need to be provided for each of the systems to be an effective near-term solution for digitizing the UH-60 cockpit.

The findings of this assessment provide insights that could also aid in the development of moving map displays for several other Army aviation systems and concepts. These include the RAH-66 and CH-47F helicopter crew stations, display requirements for the future transport rotorcraft, and development of the Air Warrior electronic data manager.

INTENTIONALLY LEFT BLANK

ABBREVIATED ASSESSMENT OF THREE MOVING MAP DISPLAYS FOR THE UH-60 HELICOPTER

1. Introduction

1.1 Background

The UH-60 is a dual engine helicopter that is used for tactical transport of troops, supplies, and equipment. It will begin reaching its service life goal of 30 years in 2007. Increased operational tempo and the technological age of the basic airframe, components, and systems are having an adverse impact on the useful life of the aircraft (Department of the Army, 1998a). Additionally, the UH-60 does not have the necessary digital avionics architecture to meet current and future interoperability communication requirements. In order to address these shortcomings, the Army is planning to modernize the UH-60. The modernization effort is referred to as the UH-60M program and will include improvements in the airframe and mission equipment package (MEP). Improvements in the MEP include a digital moving map display that will enhance situational awareness and help minimize workload for pilots. Because it will take several years until the UH-60 fleet is modernized, the Program Manager for Utility Helicopters is exploring the potential of existing systems and technologies to provide a near-term solution for digitizing the aircraft.

1.2 Purpose

The purpose of this assessment was to evaluate the human factors characteristics of three moving map display systems that could be used as part of the near-term solution for digitization of the UH-60. The systems included the Peregrine digital map, Appliqué V2 computer and Force XXI Battle Command–Brigade and Below (FBCB2) software, and the Primary Selectable Mission Support System (PRISMS2). This assessment was requested by the Program Manager for Utility Helicopters, in association with the Air Maneuver Battle Laboratory at Fort Rucker, Alabama.

1.3 Description of Systems

1.3.1 Peregrine Digital Map

The Peregrine digital map is a system that combines commercially available electronic and computer components (see Figure 1), global positioning system (GPS) satellite data, National Imaging Management Agency (NIMA) digital map

data, and proprietary software to enhance the process of mission planning and execution. It allows aircrews to graphically load map, obstacle, and threat data into the system during mission planning. During flight, Peregrine displays a map of the area, the aircraft's position on that map, and the location of any nearby way points, phase lines, threat units, obstacles, or other battlefield elements.

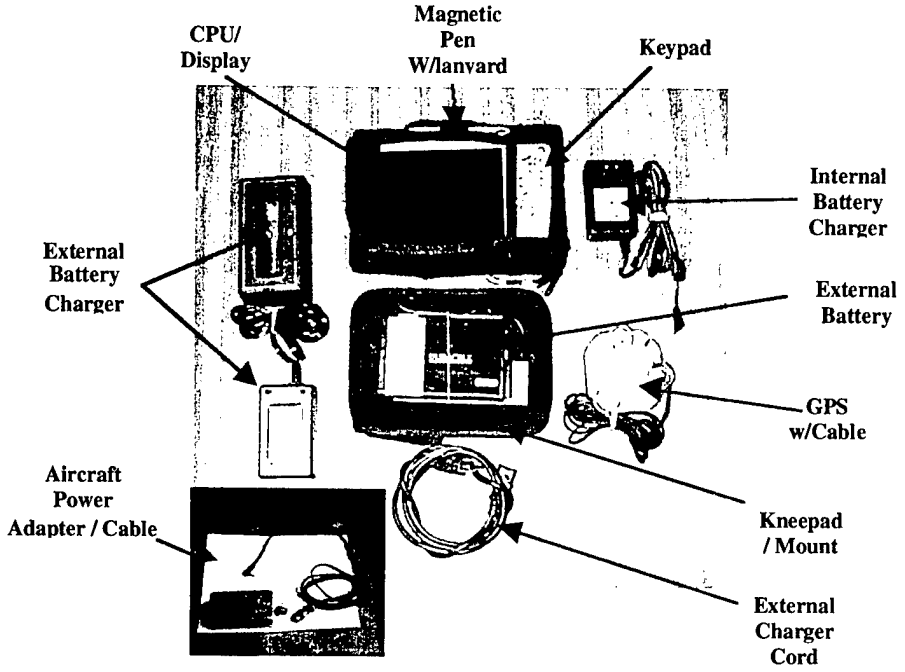


Figure 1. Peregrine Digital Map.

Additionally, the system can display flight status data such as present position, bearing, altitude, time ahead or behind schedule, course deviation, and predicted time to next way point. During the assessment, pilots wore the Peregrine display unit on their knees in the same manner as a knee board. The dimensions of the display unit were 12.0 inches long, 8.0 inches wide, and 2.0 inches deep. The size of the liquid crystal display was 6.0 inches vertical and 8.0 inches horizontal. Peregrine is being developed by Kouwen-Hoven & Hoskins, Inc., for commercial and military use.

1.3.2 Appliqué V2 Computer and FBCB2 Software

Appliqué is the computer hardware that hosts the FBCB2 software (see Figure 2). The FBCB2 software is a digital, battle command information system that is being developed to provide soldiers with integrated, mobile, real-time and near-real time, battle command information and situational awareness from brigade down to the soldier-platform level (Dept. of the Army, 1998b). The software will be interconnected between platforms (e.g., tanks and helicopters) through a communications infrastructure called the tactical internet. FBCB2 provides the

user with a digital moving map display and overlays. The digital moving map portrays a common situational awareness picture that includes

- Friendly, enemy, and neutral force locations
- Operational graphics
- Operational status
- Own location
- Display of friendly positions within a unit
- Foreign and allied maps
- City and utility maps

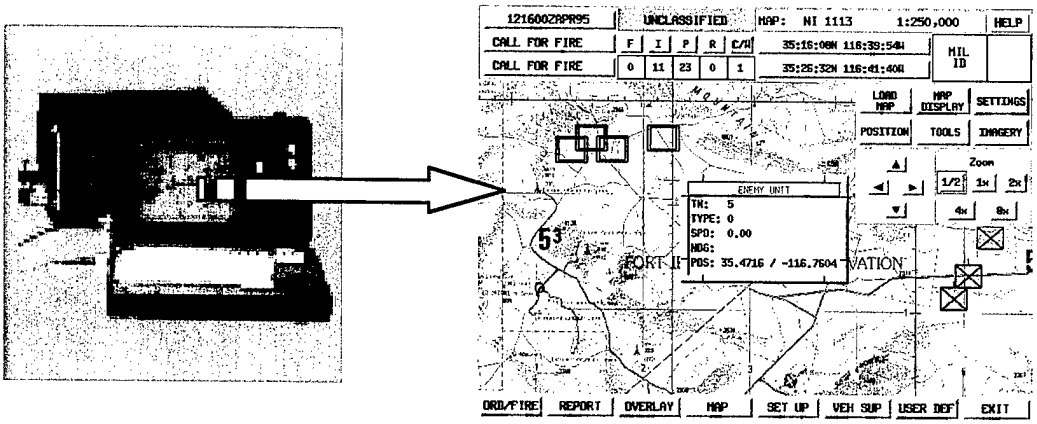


Figure 2. Appliqué V2 Computer and FBCB2 Software Display Screen.

The FBCB2 software used during the assessment was Version 2.1.a. FBCB2 is currently being developed with an initial operational test and evaluation scheduled for FY02. The hardware consisted of an enhanced Appliqué V2 computer with a 200-MHz Pentium processor, 80 megabytes of random access memory (RAM), 4.0-gigabyte hard disk drive, 5.67-inch (vertical) by 7.56-inch (horizontal) liquid crystal color display, keyboard, and trackball; the hardware was mounted in a rack assembly. The rack assembly (see Appendix A) is used for ease of transport and mounting. The Appliqué computer hardware will be improved in the future to provide the user with increased processing capability and an improved interface (e.g., larger display).

1.3.3 PRISMS2

PRISMS2 is a flight management system (see Figure 3) being developed by the U.S. Aviation Applied Technology Directorate, Fort Eustis, Virginia. It will provide a moving map display that will be improved with global positioning system (GPS) satellite data, a selectable flight instrument display (e.g., horizontal situation indicator), input devices for data entry and retrieval, digital

connectivity with other platforms, and 1553B bus capability for non-bused aircraft. The size of the moving map display evaluated during the assessment was 6.0 inches vertical by 8.0 inches horizontal. The size of the flight instrument display was 4.0 inches vertical by 5.0 inches horizontal. The moving map display can also function as a flight instrument display. The PRISMS2 components are depicted in a stand-alone configuration (with electronics rack) in Appendix B. PRISMS2 has been integrated into the cockpit of a UH-1 test bed aircraft and flown for approximately 10 hours. It has also been installed in the cabin of an UH-60 and flown for 8 hours as a proof-of-concept effort.

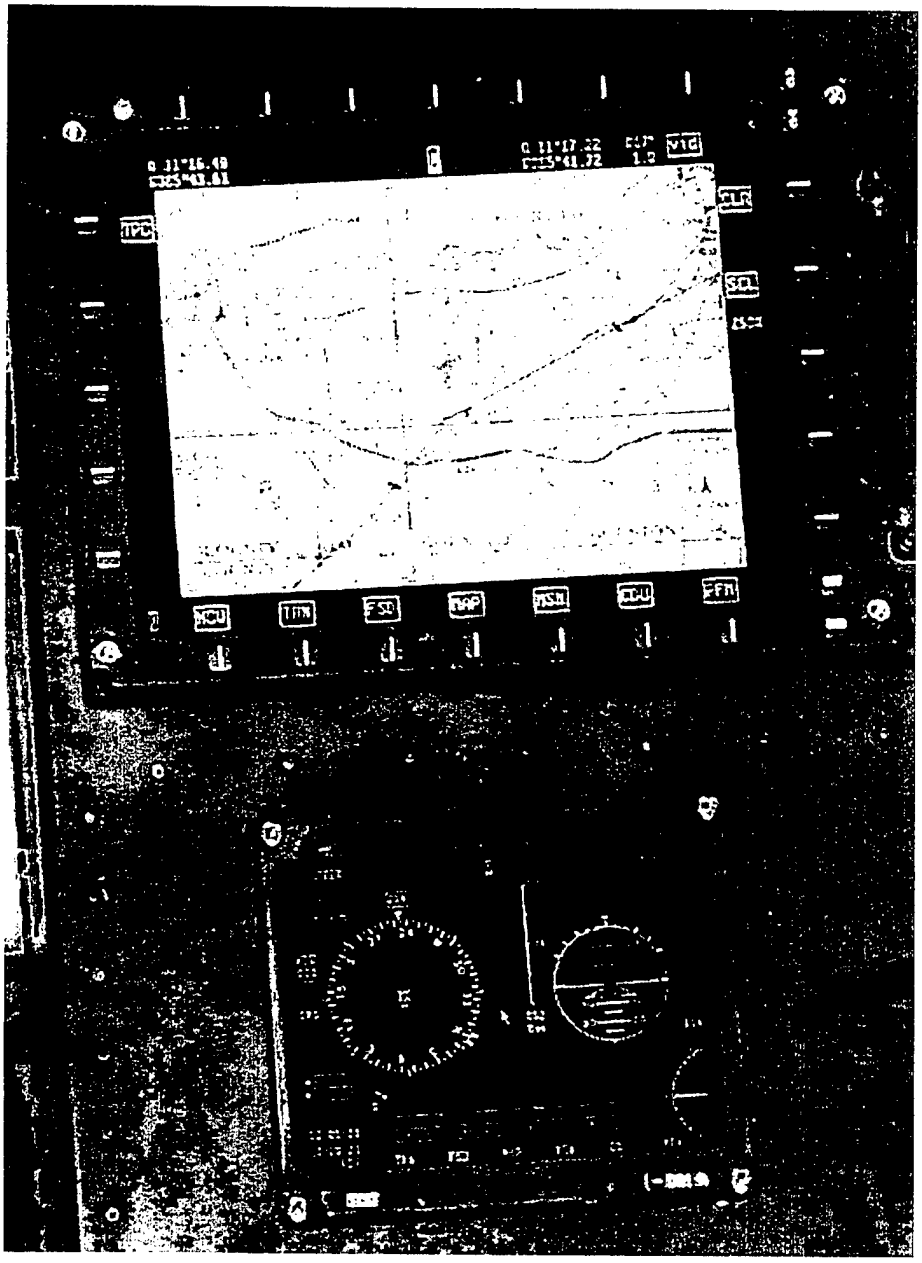


Figure 3. PRISMS2 Digital Moving Map and Flight Instrument Displays.

2. Method

2.1 Subjects

2.1.1 Peregrine Digital Map

Subjects were five male Army pilots from B and C Companies, 2nd Battalion, 4th Brigade, 4th Infantry Division, Fort Hood, Texas. They represented a group of moderate to highly experienced UH-60 pilots with a range from 500 hours to 3,200 hours of flight time in Army aircraft. The pilots flew in standard flight gear, including their survival vests. The average amount of time they spent using Peregrine during flight operations was 8.25 hours. The relevant demographic characteristics of the pilots are listed in Table 1.

Table 1. Demographic Characteristics of Pilots

Summary of demographic characteristics	Age (yrs.)	UH-60 flight hours	Total flight hours	Flight hours with NVGs[a]
Peregrine digital map (N=5)				
Average	33	1582	1760	505
Median	36	1420	1500	275
Range	26-40	120-3070	500-3200	50-1200
Appliqué-FBCB2 (N=5)				
Average	35	800[b]	1827	546
Median	34	799[b]	1200	150
Range	31-42	500-1100[b]	550-5470	100-2200
PRISMS2 (N=9)				
Average	40	1292[b]	3252	472
Median	37	1039[b]	2100	200
Range	31-53	460-4000[b]	680-7000	110-2200

[a]NVGs = night vision goggles
[b]Excludes CH-47 pilot used in assessment

2.1.2 Appliqué V2 Computer and FBCB2 Software

Subjects were five male Army pilots. They were assigned to the following units: A Company, 2nd Battalion, 4th Brigade, 4th Infantry Division, Fort Hood, Texas (one pilot), the Directorate of Evaluation and Standardization, Fort Rucker, Alabama (one pilot) and the Air Maneuver Battle Laboratory, Fort Rucker, Alabama (three pilots). They represented a group of moderate to highly experienced pilots with a range from 550 hours to 5,470 hours of flight time in Army aircraft. Four subjects were UH-60 pilots and one subject was a CH-47 pilot. The CH-47 pilot participated in the assessment because he was a highly experienced aviator and because of the similarity between cargo and utility helicopter missions. Only one of the subjects had previous experience using the Appliqué system in an operational environment. The relevant demographic characteristics of the pilots are listed in Table 1.

2.1.3 PRISMS2

Subjects were nine male Army pilots. They were assigned to the following units: F Company, 1-212 Aviation Regiment, Fort Rucker, Alabama (two pilots), the Directorate of Combat Developments, Fort Rucker, Alabama (three pilots), the Air Maneuver Battle Laboratory, Fort Rucker, Alabama (three pilots) and the Directorate of Evaluation and Standardization, Fort Rucker, Alabama (one pilot). They represented a group of moderate to highly experienced pilots with a range from 680 hours to 7,000 hours of flight time in Army aircraft. Eight subjects were UH-60 pilots and one subject was a CH-47 pilot. The CH-47 pilot was the same subject who participated in the assessment of the Appliqué V2 computer and FBCB2 software. None of the subjects had previous experience using the PRISMS2. The relevant demographic characteristics of the pilots are listed in Table 1.

2.2 Procedure

The assessment of the Peregrine digital map was conducted on 11-13 August 1998 at the National Training Center (NTC), Fort Irwin, California, and on 24-25 August 1998 at Hood Army Airfield, Fort Hood, Texas. The pilots were trained in the operation of the Peregrine system before the assessment. The method used by U.S. Army Research Laboratory (ARL) personnel to collect data included structured observations of aircrew performance during flight and post-flight debriefings. The pilots also completed a series of surveys about their assessment of the human factors characteristics of the Peregrine. The surveys addressed the impact of Peregrine on aircrew workload and situational awareness when the displays are used in the cockpit for pilotage, navigation, and mission tasks (Department of the Army, 1996). The surveys also addressed the hardware and software usability characteristics of the system. They were developed in accordance with published guidelines for proper format and content (Babbitt &

Nystrom, 1989). A brief pre-test was conducted to refine the surveys and to ensure that they could be easily understood and completed by pilots.

The Appliqué-FBCB2 assessment was conducted on 16 December 1998 at the Software Engineering Directorate, Missile Research and Development Engineering Center, Redstone Arsenal, Alabama. The PRISMS2 assessment was conducted on 3-4 February 1999 at the Air Maneuver Battle Laboratory, Fort Rucker, Alabama. The method of assessment (see Figure 4) of the two systems was very similar and included a structured briefing and demonstration of their functionality to the Army pilots. The demonstration was followed by limited "hands-on" interaction with the system by the pilots and discussions about its usability in the UH-60 cockpit. A sun lamp was used by ARL personnel to help the pilots evaluate the sunlight readability of the displays. The pilots then completed the same surveys as those used to assess the Peregrine digital map.

The Peregrine digital map was assessed during flight operations because the cost for incorporating it into the aircraft was minimal. The Appliqué-FBCB2 and PRISMS2 were not assessed during flight operations because the cost for incorporating them into the aircraft was prohibitive.

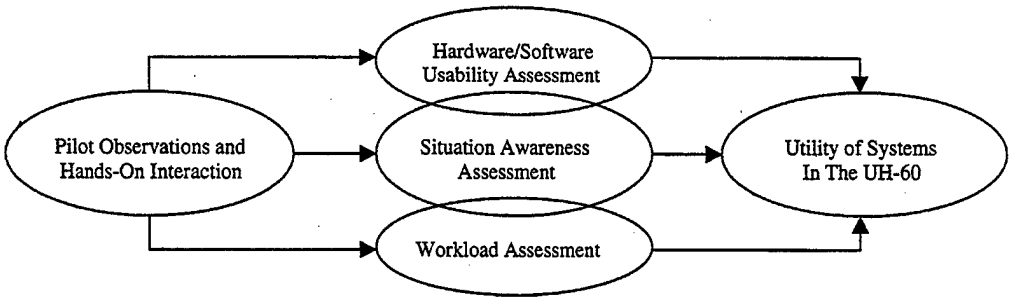


Figure 4. Overview of the Procedure Used to Assess the Appliqué-FBCB2 and PRISMS2.

2.3 Data Analysis

The workload, situational awareness, and hardware-software survey data were analyzed with a chi-square goodness-of-fit test (for rating scale responses) or binomial test (for "yes-no" responses) to determine any statistically significant response trends to survey items. Statistically significant response trends indicate that the responses provided by the pilots to a particular survey item were not random but were probably attributable to a systematic factor such as a strong like or dislike for a particular characteristic of the system. Because of the small number of pilots who were surveyed, an exact chi-square (or binomial) probability value was computed for each survey item.

2.4 Limitations of Assessment

Schedule and funding constraints precluded a comprehensive assessment of the human factors characteristics of the Peregrine digital map, Appliqué-FBCB2, and PRISMS2 systems. These constraints limited the time that was available to conduct the assessments and prevented the assessment of the Appliqué-FBCB2 and PRISMS2 systems during flight. Additional limitations included the small sample sizes of pilots who participated in the assessment of each system and safety concerns which prevented the use of the Peregrine digital map during tactical missions. Because the pilots were not allowed to use the Peregrine system during tactical missions, they did not answer a portion of the workload and situational awareness survey questions. Finally, the same pilots were not used to assess each system. Therefore, the systems should not be directly compared to each other but assessed on their individual potential to help provide a near-term solution for digitizing the aircraft.

3. Results

3.1 Workload

Based on the judgment of the pilots who participated in the assessments, it appears that each system has the potential to reduce a portion of the workload associated with specific pilotage, navigation, and mission tasks in the UH-60. This is because the time required to access and monitor pilotage, navigation, and tactical mission data would be decreased in comparison to current methods and systems (i.e., paper map) used in the UH-60. Reduction of the workload associated with these tasks could allow the aircrews additional time to perform other flight-related tasks and therefore be more efficient cockpit managers. A statistically significant percentage of the responses provided by the pilots indicated that using the Peregrine digital map, PRISMS2, or Appliqué-FBCB2 in the UH-60 during a mission would reduce workload for the tasks listed in Table 2.

3.2 Situational Awareness

Each system appears to have the potential to enhance the situational awareness of specific battlefield elements for aircrews, based on the judgement of the pilots who participated in the assessments. This is primarily because of the instant feedback that the map display would provide aircrews about the identity and relative location of the battlefield elements (when compared to current methods, i.e., paper map). A statistically significant percentage of the responses provided by the pilots indicated that using the Peregrine digital map, Appliqué-FBCB2, or

PRISMS2 in the UH-60 during a mission would increase situational awareness of the battlefield elements listed in Table 3.

Table 2. Pilotage, Navigation, and Mission Tasks That Would Require a Smaller Workload

Peregrine digital map	Appliqué-FBCB2	PRISMS2
Determine present position of aircraft	Determine present position of their aircraft	Determine present position of their aircraft
Maintain ground track	Way point identification	Maintain ground track
Way point identification	Identification of terrain Features	Way point identification
	Move to and occupy an assembly area	Maintain heading
	Conduct air movement operations	Determine time ahead or behind schedule
	Perform command and control mission support	Determine distance to object
	Conduct air assault operations	Correlate flight display information with digital map information
	Perform in-flight change of missions	Contour flight
	Avoid threat	Low level flight
		Perform command and control mission support
		Conduct air assault operations
		Return to assembly area
		Perform in-flight change of Mission
		Perform passage of lines
		Avoid obstacles
		Avoid threat
		Perform crew coordination Tasks
		Perform decision-making tasks

Table 3. Battlefield Elements for Which Situational Awareness Would be Increased

Peregrine digital map	Appliqué-FBCB2	PRISMS2
Location of their aircraft	Location of their aircraft	Location of their aircraft
Location of friendly elements	Location of friendly elements	Location of friendly elements
Location of threat elements		Location of threat elements
		Location forward arming and refueling points
		Location of assembly areas
		Location of air control points
		Location of pick-up zones
		Location of landing zones
		Location of starting points
		Location of release points
		Ingress flight route
		Egress flight route

3.3 Hardware and Software Interface

The usability characteristics of the hardware and software interface can have a significant impact on whether the systems enhance situational awareness and minimize workload for pilotage, navigation, and mission tasks. Most pilots reported that several hardware and some software characteristics of the Peregrine digital map and Appliqué-FBCB2 would need to be improved in order for the systems to be suitable for use during flight operations. Several of the same usability characteristics of the Appliqué-FBCB2 were also reported as problems during the 1997 Task Force XXI Army Warfighting Experiment (Durbin, 1997) when the system was used in the cabin of an UH-60 for fire support tasks. Most pilots reported that most of the hardware and software interface characteristics of PRISMS2 were adequate. However, the pilots did report some concerns about potential problems they might encounter during flight. Usability problems reported for each system are listed in Table 4.

During post-flight debriefings, pilots who wore the Peregrine digital map expressed concern that wearing the display unit on their knees (as a knee board) was a safety issue because the unit interfered with cyclic and collective

movement. Wearing the unit on their knees also prevented the other pilot's viewing the display. Additionally, some of the pilots expressed concern that wearing the unit on their knees forced them to shift their visual focus too far inside the cockpit to access information on the display. They preferred to have the unit mounted on the front instrument panel for easier visual access. They further reported that mounting it on the front of the instrument panel would increase sunlight readability and help the other pilot to see the display (see Figure 5).

Table 4. Hardware and Software Usability Problems Reported by Pilots

Peregrine digital map	Appliqué-FBCB2	PRISMS2
Reduce the number of steps required to enter and retrieve data	Reduce display clutter	Provide adequate access to PRISMS2 in the cockpit by both pilots or provide both pilots with their own individual moving map display
Minimize display screen clutter	Minimize display vibration during flight	Is the flight instrument display really needed since it is redundant with current aircraft flight instruments
Reduce display vibration during flight	Increase display size	Increase the size of the flight instrument display
Improve off-axis viewability of the display	Improve display resolution	Entry of data into PRISMS2 during flight could be a problem (e.g., because of vibration)
Improve readability of symbology displayed on the moving map	Increase display contrast	
Increase sunlight readability of the display (see Figure 5)	Improve off-axis viewability	
Eliminate interference between the Peregrine display unit and cyclic-collective when flight control movements are made (see Figure 5)	Reduce display glare	
	Provide NVG compatibility	
	Reduce bulkiness of the system	
	Incorporate standard symbology sets on the map	

Figure 5. Example of Sunlight Readability and Cyclic-Collective Interference Problems.

4. Conclusions

Overall, the results indicate that the use of the Peregrine digital map, Appliqué-FBCB2, or PRISMS2 in the UH-60 cockpit could enhance the performance of several pilotage, navigation, and mission tasks by aircrews. This is based on the pilots' judgment that the systems would enhance situational awareness of several battlefield elements and help minimize workload for specific pilotage, navigation, and mission tasks. This would be primarily because of the instant feedback that the systems could provide aircrews about the location of their aircraft and the identity and relative position of battlefield elements such as friendly and threat units. Significant improvements in the hardware and software interface of the Appliqué-FBCB2 and Peregrine digital map would have to occur before it would be suitable for use in the UH-60 cockpit. Improvements in the hardware and software interface of the PRISMS2 would enhance its usability in the cockpit. Finally, interoperability with the Aviation Mission Planning System (AMPS) would need to be provided in order for each of the systems to be an effective near-term solution for digitizing the UH-60 cockpit.

Interoperability with AMPS would allow aircrews to load their mission data into the systems quickly and efficiently.

PRISMS2 was rated by pilots as having the potential to help minimize workload for more pilotage, navigation, and mission tasks and enhance situational awareness of more battlefield elements than either the Peregrine digital map or Appliqué-FBCB2. This is probably because PRISMS2 is being developed specifically for use as a pilotage and navigation device for non-bused Army aircraft. The Peregrine digital map is being developed for general commercial and military use, and Appliqué-FBCB2 is being developed for use across several different Army platforms (e.g., tracked and wheeled vehicles). Therefore, they would probably be less suited for use in the UH-60 cockpit than PRISMS2.

5. Discussion and Recommendations

The limitations of this assessment did not allow an in-depth evaluation of the human factors characteristics of the Peregrine digital map, Appliqué-FBCB2, or PRISMS2 systems. However, the survey responses provided by the Army pilots serve as useful insights about the utility of the systems by UH-60 aircrews. The survey responses also provide insights that could aid in the development of several other Army aviation systems and concepts. These include moving map displays for the RAH-66 and CH-47F helicopter crew stations, moving map display requirements for the future transport rotorcraft, and development of the Air Warrior electronic data manager.

The findings of this report identify potential design limitations that should be the focus of a comprehensive assessment. If modification of any of the systems for use in the UH-60 cockpit is undertaken, all the potential design limitations listed in this report should be addressed. Additionally, the systems should follow established requirements and guidelines (Department of the Army, 1988) for operation in Army aircraft, including development of an effective soldier-system software and hardware interface. It is also recommended that an initial in-flight assessment be conducted to fully determine the level of usability of each system in the UH-60 cockpit. The assessment should be conducted with the most current hardware and software configuration for each system. It should employ a large sample size of aviators with a wide range of experience and should include evaluation of representative 5th percentile female through 95th percentile male anthropometric dimensions.

INTENTIONALLY LEFT BLANK

References

Babbitt, B., & Nystrom, C. (1989). Questionnaire construction manual. Fort Hood, TX: U.S. Army Research Institute.

Department of the Army (1988). Lighting, aircraft, interior, night vision imaging system (NVIS) compatible (MIL-L-85762A). Washington, DC: Author.

Department of the Army (1996). Aircrew training manual, utility helicopter, UH-60/EH-60 (Training Circular 1-212). Washington, DC: Author.

Department of the Army (1998a). Operational requirements document (ORD) for the UH-60(X) black hawk utility helicopter. Fort Rucker, AL: Author.

Department of the Army (1998b). Operational requirements document (ORD) for Force XXI battle command–brigade and below (FBCB2). Fort Knox, KY: Author.

Durbin, D.B. (1997). Evaluation of the human factors characteristics of the interim army airborne command and control system (A2C2S) (unpublished report). Fort Rucker, AL: U.S. Army Research Laboratory.

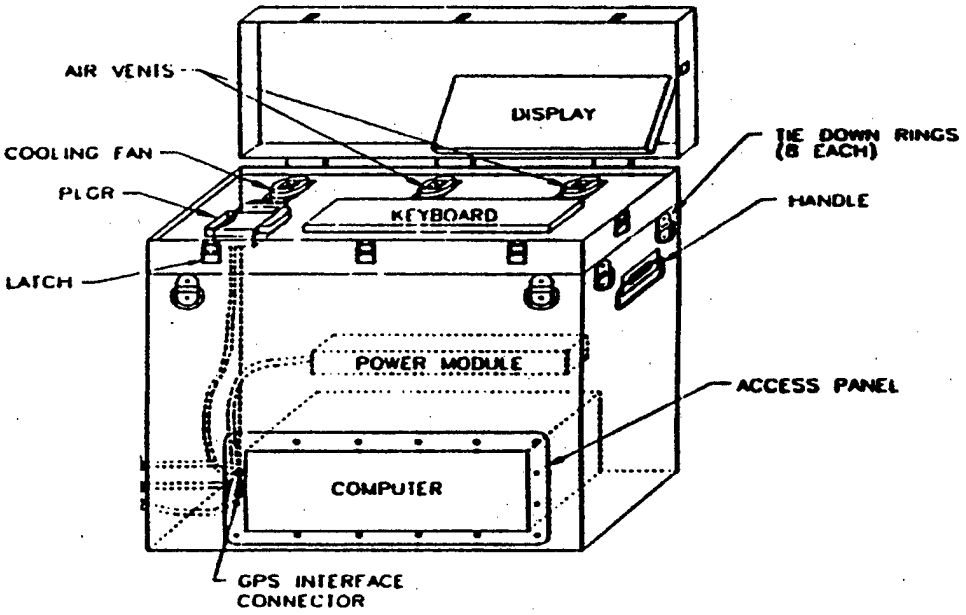
INTENTIONALLY LEFT BLANK

APPENDIX A

RACK ASSEMBLY FOR THE APPLIQUÉ V2

INTENTIONALLY LEFT BLANK

RACK ASSEMBLY FOR THE APPLIQUÉ V2



Dimensions of Rack Assembly

Height (Lid open) – 41.0 inches

Length – 27.0 inches

Depth – 18.0 inches

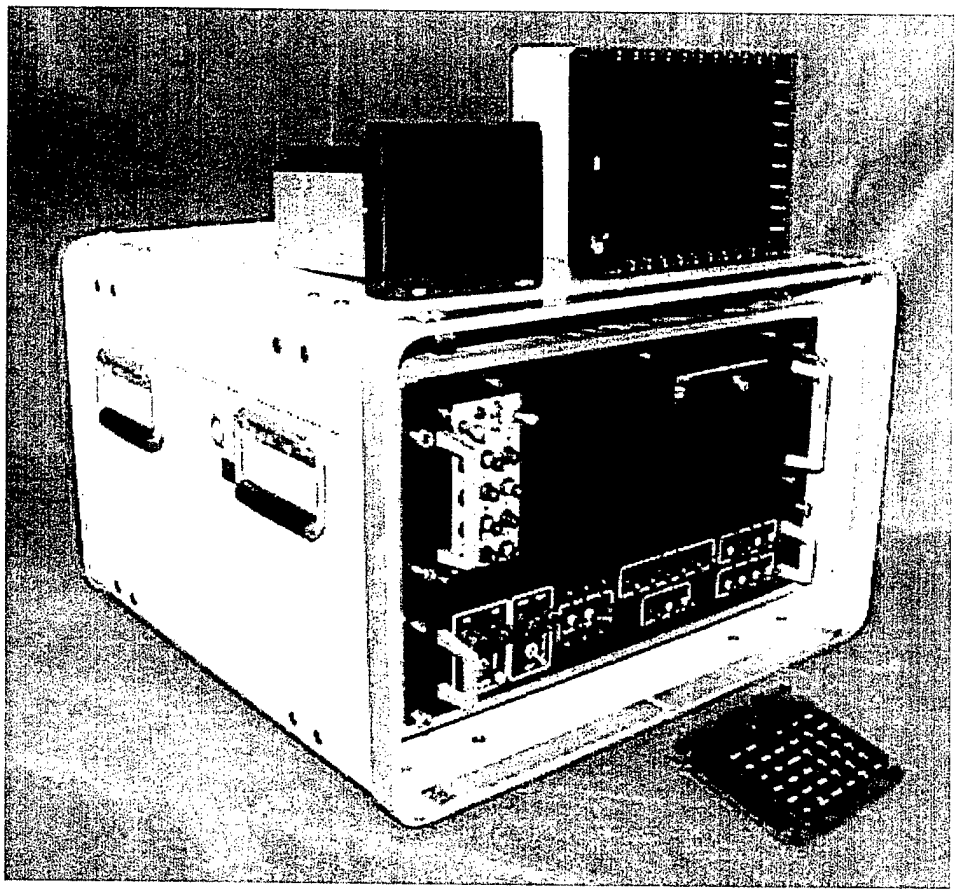
INTENTIONALLY LEFT BLANK

APPENDIX B

PRISMS2' COMPONENTS IN STAND-ALONE CONFIGURATION

INTENTIONALLY LEFT BLANK

PRISMS2' COMPONENTS IN STAND-ALONE CONFIGURATION



INTENTIONALLY LEFT BLANK

APPENDIX C

SUMMARY OF PILOT RESPONSES ABOUT THE IMPACT OF APPLIQUÉ-FBCB2 ON WORKLOAD

INTENTIONALLY LEFT BLANK

SUMMARY OF PILOT RESPONSES REGARDING THE IMPACT OF APPLIQUÉ-FBCB2 ON WORKLOAD

Tasks	Appliqué Would Significantly Decrease Workload	Appliqué Would Moderately Decrease Workload	No Difference	Appliqué Would Moderately Increase Workload	Appliqué Would Significantly Increase Workload	N/A
Flight and Navigation Tasks:	------	------	------	------	------	-----
Determine present position of aircraft[a]	80%	20%	0%	0%	0%	0%
Maintain heading[a]	0%	20%	80%	0%	0%	0%
Maintain ground track	0%	60%	40%	0%	0%	0%
Maintain altitude[a]	0%	0%	100%	0%	0%	0%
Determine time ahead/behind schedule	20%	20%	20%	40%	0%	0%
Determine distance to object	20%	40%	20%	20%	0%	0%
Way point identification[b]	0%	100%	0%	0%	0%	0%
Identification of terrain features[a]	0%	80%	20%	0%	0%	0%
Correlating flight display information (e.g., air speed) with digital map information	0%	20%	40%	0%	0%	40%
NOE Flight	0%	60%	40%	0%	0%	0%
Contour Flight	0%	60%	40%	0%	0%	0%
Low Level Flight	0%	60%	40%	0%	0%	0%
General Mission Tasks:	------	------	------	------	------	------
Preparing for air movement operations	20%	20%	0%	20%	0%	40%
Moving to and occupying an assembly area[a]	0%	80%	0%	0%	0%	20%
Conducting air movement operations[a]	0%	80%	0%	0%	0%	20%
Performing command and control mission support[a]	0%	80%	0%	0%	0%	20%
Reporting intelligence data	20%	40%	0%	40%	0%	0%

Tasks	Appliqué Would Significantly Decrease Workload	Appliqué Would Moderately Decrease Workload	No Difference	Appliqué Would Moderately Increase Workload	Appliqué Would Significantly Increase Workload	N/A
Returning to assembly area	0%	60%	40%	0%	0%	0%
Performing actions on contact	0%	20%	20%	60%	0%	0%
Conducting air assault operations[a]	0%	80%	0%	0%	20%	0%
Conducting downed aircrew recovery operations	0%	60%	40%	0%	0%	0%
Performing passage of lines	0%	40%	60%	0%	0%	0%
Conducting FARP refueling[b]	0%	0%	100%	0%	0%	0%
Sling load operations[a]	0%	0%	80%	0%	0%	20%
Performing in-flight change of mission[c]	40%	40%	0%	0%	0%	20%
In-flight route planning	20%	0%	40%	20%	20%	0%
Threat avoidance[c]	20%	60%	20%	0%	0%	0%
Obstacle avoidance	0%	60%	20%	0%	0%	20%
General Aircrew Tasks:	------	------	------	------	------	------
Monitoring aircraft status	0%	20%	60%	0%	0%	20%
Radio calls	0%	40%	40%	0%	0%	20%
Crew coordination	0%	20%	0%	40%	20%	20%
Decision making	0%	60%	20%	20%	0%	0%
Prioritizing actions	0%	40%	20%	20%	0%	20%
Manage unexpected events	0%	40%	60%	0%	0%	0%
Time to perform additional tasks	0%	40%	20%	20%	20%	0%

[a]Significant at α .05, indicating a non-random response trend.
[b]Significant at α .01, indicating a non-random response trend.
[c]Significant at α .05 when cells for decreased workload are combined into one cell

If you rated a task as having significantly increased or decreased workload while using the Appliqué-FBCB2, describe why the level of workload was higher or lower:

Pilot Comments:

- Present position, friendly and enemy situation in the cockpit is great. Allows us to react in flight. We can receive new missions in overlay form right in the cockpit. This will require more time inputting routes and other data into Appliqué. This will create a need for more mission planning time.
- Reporting intel – message format with time stamp and location speeds up the process and requires less time than radio calls.
- In-flight change of mission and route planning – digitally transmit changes to other aircraft in flight of multi-ship decreases workload.
- Using Appliqué to prepare for an Air Movement operation would significantly increase workload. This is because the Appliqué does not assist planning for any operation, so if I were to utilize the Appliqué, I would still have to conduct planning, coordination, etc., and then spend time manually inputting LZ's, PZ's, timelines, etc. Thus, if I use Appliqué, my workload increases significantly. In reality, I would not use Appliqué for "preparing" because it does not have that capability. Make Appliqué compatible with AMPS. Plan missions with AMPS, take the disk out of AMPS, plug it into the Appliqué, with routes, execution checklists, air movement checklists, etc. Thus, time to plan mission/prep for missions decreases. If this could be done in the TOC, planning (AMPS) and if the data could be transmitted to the aircraft in flight, you could dynamically retask aircraft.
- There are too many keystrokes and trackball movements required to perform. Requires operator to be inside on keyboard.
- The Appliqué is in the cargo area of the aircraft which means you need a third pilot which increases workload to communicate information.

INTENTIONALLY LEFT BLANK

APPENDIX D

SUMMARY OF PILOT RESPONSES ABOUT THE IMPACT OF APPLIQUÉ-FBCB2 ON SITUATIONAL AWARENESS

INTENTIONALLY LEFT BLANK

SUMMARY OF PILOT RESPONSES ABOUT THE IMPACT OF APPLIQUÉ-FBCB2 ON SITUATIONAL AWARENESS

Battlefield Element	Appliqué Would Significantly Increase Situational Awareness	Appliqué Would Moderately Increase Situational Awareness	No Difference	Appliqué Would Moderately Decrease Situational Awareness	Appliqué Would Significantly Decrease Situational Awareness	N/A
Location of ownship during the mission[c]	20%	60%	20%	0%	0%	0%
Location of friendly assets[a]	20%	80%	0%	0%	0%	0%
Location of threat	20%	40%	0%	20%	0%	20%
Location of FARP	20%	40%	20%	0%	0%	20%
Location of Assembly Area	0%	60%	20%	0%	0%	20%
Location of ACP's	0%	60%	40%	0%	0%	0%
Location of PZ's	0%	20%	60%	0%	0%	20%
Location of LZ's	0%	20%	60%	0%	0%	20%
Location of SP's	0%	40%	60%	0%	0%	0%
Location of RP's	0%	40%	60%	0%	0%	0%
Ingress Flight Route	20%	0%	40%	20%	0%	20%
Egress Flight Route	20%	0%	40%	20%	0%	20%
Ownship fuel status	0%	0%	20%	0%	0%	80%
Natural terrain features	0%	40%	40%	0%	0%	20%
Man-made terrain features	0%	40%	40%	20%	0%	0%

If you rated a task as having significantly increased or decreased situational awareness while using Applique, describe why the level of situation awareness was higher or lower:

Pilot Comments:

- The S.A. on the map is superb. It eliminates the need to constantly re-check your own position on hand-held map. Allows more time to react to your environment.
- Display of spot reports on the omni-directional map display raised my level of awareness.

[a]Significant at α .05, indicating a non-random response trend.
[c]Significant at α .05 when cells for increased situational awareness are combined into one cell.

INTENTIONALLY LEFT BLANK

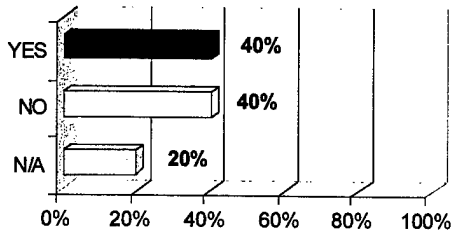
APPENDIX E

SUMMARY OF PILOT RESPONSES ABOUT HARDWARE-SOFTWARE INTERFACE CHARACTERISTICS OF THE APPLIQUÉ-FBCB2

INTENTIONALLY LEFT BLANK

SUMMARY OF PILOT RESPONSES ABOUT HARDWARE-SOFTWARE INTERFACE CHARACTERISTICS OF THE APPLIQUÉ-FBCB2

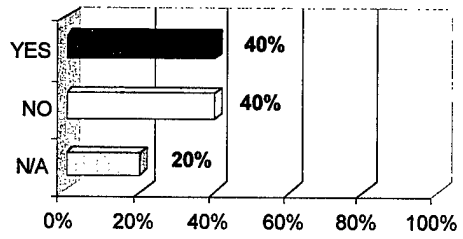
Do You Expect To Experience Problems Entering Data Into Applique?



Pilot Comments:

- Vibration during flight was a problem during Task Force XXI.
- It is very difficult to type information during flight based on TF XXI experience.
- Keyboard entry at night is almost impossible.
- Positioning of seat – bent over operating keyboard will be a problem.
- Current configuration requires additional person to operate the system.
- Data entry on keyboard will be a problem.
- There will be problems during NOE flight, and ±30°/60° pitch and roll flight. During straight and level flight on a nice day, there should be minimal problems.

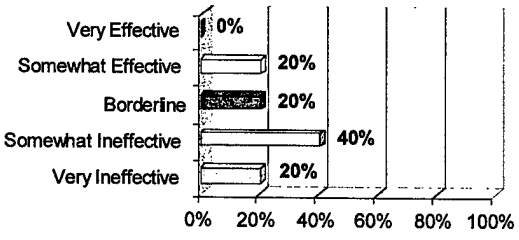
Are There Any Hardware Features That Are Not Logical Or Consistent?



Pilot Comments:

- System is too big and bulky.
- There is no good location in cockpit to put it.
- System would be unusable to pilots.
- Data entry with keyboard and trackball is a problem.

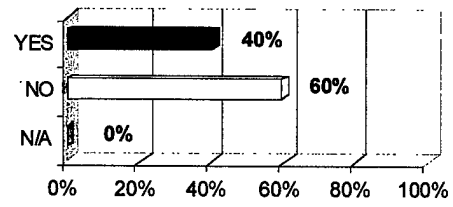
How Effective Is The Size Of The Digital Map Screen For Displaying And Entering Data?



Pilot Comments:

- Screen is too hard to see and comprehend with a moment's glance for the pilot on the controls.
- Size is usable, but a bigger screen would be better.
- Display size and resolution are a problem.
- Display needs to be bigger with better resolution.
- The windows obscure the map display.

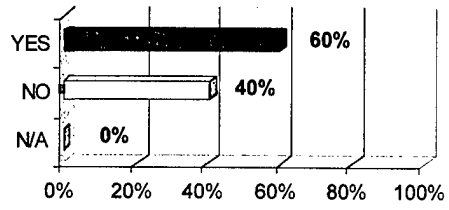
Any Symbology On The Map Or Menu Screens That Was Difficult To Understand Due To Size?



Pilot Comments:

- Unit symbols are hard to see.
- The symbols will not change size.

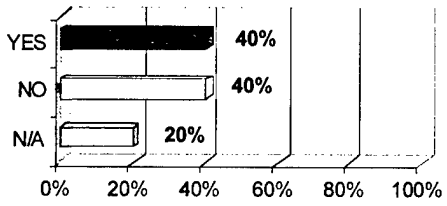
Any Symbology On The Map Or Menu Screens That Was Difficult To Understand Due To Content?



Pilot Comments:

- Symbology should be standardized (e.g., FM 101-5-1). (Comment made by 2 pilots)

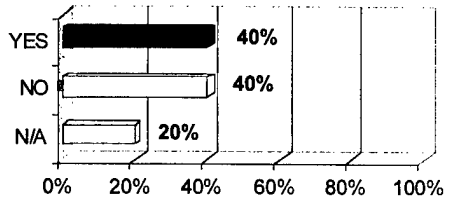
Problems Reading and Interpreting Information Due To Reflections On The Display?



Pilot Comments:

- Reflections on the display made it hard to see.
- There was reflection on the display from the lab lights.
- There were problems with reflections on display at night during TF XXI.

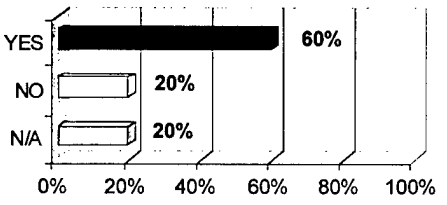
Problems Reading and Interpreting Information On The Display Due To Lack Of Adequate Contrast?



Pilot Comments:

- Map symbols and some user symbols blended black on black. For instance, ACP's. PL's, etc.
- Contrast was a problem due to the quality of the NIMA map scanned in.

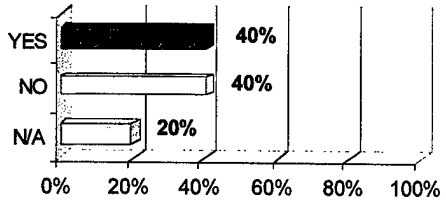
Problems Reading and Interpreting Information On The Display Due To Lack Of Adequate Resolution?



Pilot Comments:

- Resolution is not detailed enough.
- Resolution made it difficult to see information on display.
- Need to use FM 101-5-1 for symbology.
- Certain magnifications of the map degraded resolution.
- Resolution of map is not high enough. Eyestrain would become a problem on longer missions.

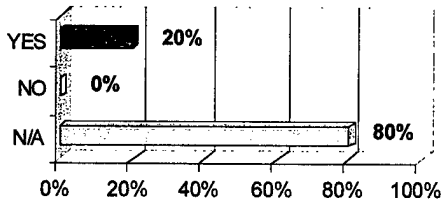
Problems Reading and Interpreting Information On The Display Due To Lack Of Adequate Brightness?



Pilot Comments:

- Brightness may be a concern when using NVG's.
- Screen too bright for Lab, may be suitable for aircraft day flight.
- Brightness made it difficult to see information on display.
- Too bright to read display with NVG's.
- Display screen is too bright, enemy can see the glow in night conditions.

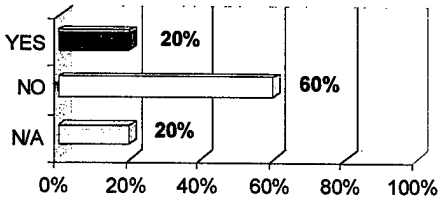
Problems Reading and Interpreting Information On The Display Due To Vibration?



Pilot Comments:

- During TF XXI, I was unable to read the display during flight due to vibrations.

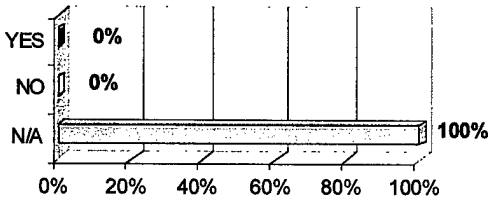
Problems Reading and Interpreting Information On The Display Due To Inadequate Off-Axis Viewability?



Pilot Comments:

- You can only see and comprehend what is on the screen if you're directly in front of it.
- Off-axis viewability is unclear and made it difficult to see information on display.

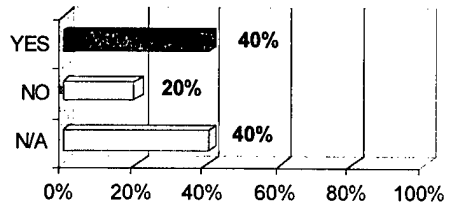
Problems Reading and Interpreting Information On The Display Due To Inadequate Sunlight Readability?



Pilot Comments:

- No significant comments.

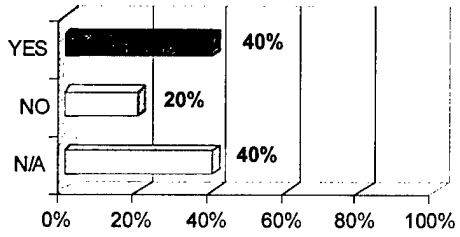
Do You Believe Applique Would Cause Any Problems With The Use Of Night Vision Goggles?



Pilot Comments:

- The screen is too bright and will cause problems for pilots.
- Applique will cause problems with night vision goggles.
- Display would illuminate inside of aircraft enough to make it visible to enemy IR systems.
- I speculate that looking at that screen during 5 hours of NVG use would be exhausting to pilots.
- Screen is too bright.

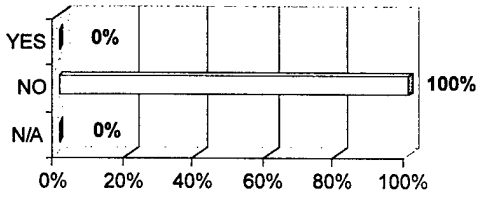
Were The Colors Used To Display Information On The Map Appropriate?



Pilot Comments:

- Maybe need to have a way of knowing (color coding) which spot reports have not been read. Showing threat icon somehow differently until that message is read.
- Yes, in most cases. Although symbols blend with map symbols.

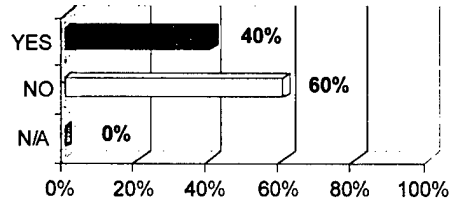
When Entering And Retrieving Information, Are There Any Steps That Are Not Logical Or Consistent?



Pilot Comments:

•No significant comments.

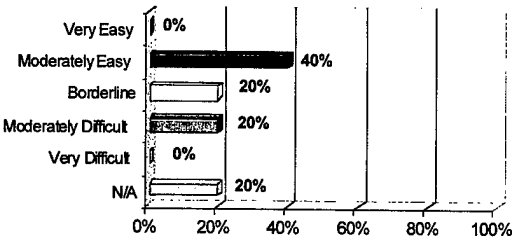
Are There Too Many Steps Required For Entering And Retrieving Information?



Pilot Comments:

- Sitting at a static console is little or no problem. Inflight may pose major challenges due to data entry procedures and requirements.
- The map size changes too slowly. With two or three paper maps on my knee, all I have to do is move it and I've got another size.

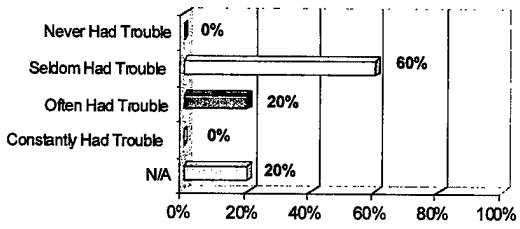
How Easy Was It To Navigate Through The Display Screens?



Pilot Comments:

- Occasional misplaced key strokes results in undesired data (on static console in a lab). I anticipate having to page thru during inflight operations.
- Too many inputs are required. This will result in too much time focused "in the cockpit".
- Navigation is borderline. This is mostly due to training. More experience with the system will decrease the workload navigation time.

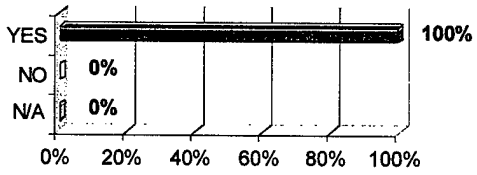
How Often Did You Have Trouble Remembering Where You Were At In The Menu Structure?



Pilot Comments:

- The engineer (who showed us the system) had some trouble.

Any Instances When The Display Screen Is Too Cluttered Making It Difficult To Read Or Enter Data?



Pilot Comments:

- As selections are made, to go to the next window, the last window does not disappear. You must go back to delete.
- The map display has to be visible at all times. All the "windows" are too big and there is no ability to change the size of the "window" by the user.
- There is clutter due to the size of the display and map resolution. The map becomes cluttered real quick at 1:50,000 and above.
- When you have the multiple message screens, it takes a little while to close them all out to get back to the map. This could limit the ability to navigate using the system.
- The window closes on some screens, but on other screens, overlap occurs.
- Some windows do not close out after execution.

What are the biggest improvements that can be made in the Appliqué -FBCB2 to make it more effective for performing your mission?

Pilot Comments:

Comments regarding the display:

- Need a better display with more viewable map area.
- Improve the screen size
- Improve the screen resolution and symbology colors.
- Digital map needs to be larger.
- Improve display size and resolution of digital map.
- Make it so everyone can see and comprehend the display (i.e., pilot, copilot, crew chief, ground commander)
- Make screen size bigger.
- System is not NVG compatible. Too much light filters into the cockpit. A screen between the cockpit and cargo area increases the likeliness of getting sick.

Comments regarding interoperability of Appliqué-FBCB2 with other systems:

- Appliqué needs to accept AMPS or other mission planning data.
- I want to plan a route on AMPS, put it on a disk and plug it into the aircraft.
- I want to be able to receive a change of mission call from TOC with the TOC doing the coordination and sending it to me via radio "on the fly".
- During TF XXI, an EPLRS radio was required for the UH-60 to "get into" the tactical internet. The EPLRS were only mounted in the Cdr's ground vehicle. If the aircraft flew over 15K, the signal was lost and situation awareness was lost.
- Previous Appliqué software had to be updated as you crossed areas in the tactical internet. The system has to do this automatically.
- Can the system pass information to another system? Has to be able to get routes from AMPS.

Comments regarding accessibility of Appliqué-FBCB2 to pilots in the cockpit:

- The current configuration cannot be seen in the cockpit. Relaying information from another crew member to the pilots does not work. Too much information is lost transferring it up front.
- The digital map needs to be accessible by both pilots.
- This current hardware is unacceptable. Must be accessible to pilots in the cockpit (both sides).
- The current Appliqué system is unacceptable as a situation awareness enhancement for utility aircraft crews. This is because the current hardware configuration provides no SA to the pilots flying the aircraft. All information must be passed via aircraft intercom system (ICS) from the cargo area to the cockpit. Additionally, the efficiency of processing data from the rear to the front would introduce a huge human error variable in the translation of what is displayed to the cockpit and vice versa. Bottom line, this system is actually a crude SA tool for an aircraft passenger. Recommend exploring other means than the current Appliqué to satisfy SA requirements to the aircraft flight control station.
- Reduce the footprint of the system.
- Hardware configuration is unsatisfactory. It takes up too much space in cargo area. Reduce size of Appliqué to fit between crew chief seats.
- The current configuration requires an additional crew member/pilot to operate the system. An effective SA tool must be operational by "minimum crew" as described in the aircraft operator's manual. The UH-60 operators manual specifies the minimum crew as two aviators rated in the UH-60 at flight control stations (cockpit). In the down sizing Army, units rarely have over 80% fill of authorized pilots. Hypothetically, if a unit were filled at authorized levels, the assigned pilots would be consumed by manning available cockpits and/or conducting other mission-essential tasks. Furthermore, safety of the system operator would be severely impacted in an emergency egress situation! Recommend exploring other means than the current Appliqué to satisfy SA requirements to the aircraft flight control station.

Comments regarding the software interface for Appliqué-FBCB2:

- Need more features (i.e., tick marks) for route planning and drawing features. For instance, need ability to select the air speed to be flown for that route of flight, then the computer "draws" time tick marks (whether counting up or down) on that segment, and also "draws" distance tick marks, whether to the next checkpoint or from the last checkpoint.
- Make the map turn based on aircraft heading and be able to turn that feature on and off.
- Need a clock that would also display H hour and elapsed mission time along with Zulu and local time.
- Make it so the user can change the size of any window, like Windows™.
- The digital map needs to be directional so it can rotate to the direction of travel.
- The overlay feature must be updated to put way points and routes. Right now, they take too long to enter a route or mission graphic.
- The new UTO address book is much better. It's easier to locate units for messaging. Need to incorporate the ability to task organize (i.e., armor/mech task force).
- Moving map centered on aircraft is great!
- Being able to move the map with box is great.
- Combat reports are super. Will require more training to set parameters correctly.
- Need to adjust ability to filter enemy units. Would like to be able to see certain icons over others (i.e., ADA over engineer).
- Need standard Army symbology.

Comments regarding the hardware interface for Appliqué:

- Develop alternatives to having to use the keyboard and trackball for data entry.
- Would be nice to have a numeric keypad – it would make type numbers (grids) easier.
- Need to be able to make easier input.
- I want vital information to be up on a heads-up-display (e.g., time, distance, heading, ground speed).

Miscellaneous comments:

- See 101st SOP for map preparation.
- The current configuration of Appliqué hardware takes up too much space in the cargo area of the aircraft. It must be mounted to a palate that reduces usable space by three seated passengers or several cubic feet of internal space. In addition to the weight of the hardware (approximately 140 pounds), weight of the mounting palate and an extra crew member with his individual equipment (planning weight of 250 pounds) could significantly restrict the aircraft's ability to efficiently execute its mission. These factors could easily double the aircraft requirement to complete the mission. Recommend exploring other means than the current Appliqué to satisfy SA requirements to the aircraft flight control system.
- SA for utility aircraft crews in the Army is greater than that of any airframe. Utility aircraft are routinely tasked beyond all lateral boundaries in theater. Often, the execution of these missions is with minimal or no pre-mission planning. It is common to receive a mission change over the radio for immediate execution. Thus, the "ground version" of SA is far less than that needed by a utility aircrew. I consider the demonstrated Appliqué software as a crude first attempt. Requirements are a real-time picture of the battlespace that can be accessed and interacted with by using user-friendly software. Keep in mind we all cannot type while sitting behind a desk. This task becomes impossible in a maneuvering platform, under "night vision goggles" in a combat zone. Recommend exploring other means than the current Appliqué to satisfy SA requirements to the aircraft flight control system.
- Need to modify/adapt Appliqué to Aviation applications.
- If there are problems, who fixes the system? Who will act as the system administrator?
- The Appliqué system has the potential to be very valuable to the UH-60 pilot. During an air assault, there is usually a dedicated staff providing enemy and friendly situation, but most of the time, we are doing "ash and trash" missions. Missions like CASEVAC and resupply, you are often prepositioned or are going to have to redirect at any time. The Appliqué gives you the

ability to conduct concurrent planning no matter where you are. This is a tremendous benefit in mission planning time and in actually having the correct situation awareness. The software would greatly assist in updates during a mission, specifically for missions requiring multiple turns (but it must be accessible in the cockpit). A crew chief in the back doesn't have the tactical knowledge to know what he is looking at and what is important, and there isn't time to teach him. A pilot in the back helps, but he will also need extra training as an administrator. In addition, we are not manned to provide an extra aviator in the aircraft.

- People cannot ride backwards in a UH-60 and read a computer screen. Nine out of 10 got sick during TF XXI AWE.
- To prepare for a mission (using Appliqué) will take longer. Still many parameters that must be preset before the mission.

APPENDIX F

SUMMARY OF PILOT RESPONSES ABOUT THE IMPACT OF PRISMS2 ON WORKLOAD

INTENTIONALLY LEFT BLANK

SUMMARY OF PILOT RESPONSES ABOUT THE IMPACT OF PRISMS2 ON WORKLOAD

Tasks	PRISMS2 Would Significantly Decrease Workload	PRISMS2 Would Moderately Decrease Workload	No Difference	PRISMS2 Would Moderately Increase Workload	PRISMS2 Would Significantly Increase Workload	N/A
Flight and Navigation Tasks:	------	------	------	------	------	------
Determine present position of aircraft[a]	56%	11%	22%	0%	0%	11%
Maintain heading[c]	33%	33%	22%	0%	0%	11%
Maintain ground track[c]	22%	45%	22%	0%	0%	11%
Maintain altitude[a]	0%	33%	56%	0%	0%	11%
Determine time ahead/behind schedule[c]	33%	33%	22%	0%	0%	11%
Determine distance to object[c]	45%	33%	11%	0%	0%	11%
Way point identification[c]	33%	45%	11%	0%	0%	11%
Identification of terrain features	11%	45%	33%	0%	0%	11%
Correlating flight display information (e.g., air speed) with digital map information[c]	22%	45%	22%	0%	0%	11%
NOE Flight	22%	33%	11%	11%	0%	22%
Contour Flight[c]	33%	33%	0%	11%	0%	22%
Low Level Flight[c]	33%	33%	0%	11%	0%	22%
General Mission Tasks:	------	------	------	------	------	------
Preparing for air movement operations	22%	33%	11%	0%	11%	22%
Moving to and occupying an assembly area	11%	33%	22%	0%	11%	22%
Conducting air movement operations	11%	45%	11%	0%	11%	22%
Performing command and control mission support[a]	11%	67%	0%	0%	11%	11%

Tasks	PRISMS2 Would Significantly Decrease Workload	PRISMS2 Would Moderately Decrease Workload	No Difference	PRISMS2 Would Moderately Increase Workload	PRISMS2 Would Significantly Increase Workload	N/A
Reporting intelligence data	22%	33%	11%	0%	0%	33%
Returning to assembly area[a]	11%	67%	0%	0%	0%	22%
Performing actions on contact	11%	45%	33%	0%	0%	11%
Conducting air assault operations[a]	11%	67%	0%	0%	11%	11%
Conducting downed aircrew recovery operations	22%	33%	22%	0%	0%	22%
Performing passage of lines[a]	22%	57%	11%	0%	0%	11%
Conducting FARP refueling	22%	33%	33%	0%	0%	11%
Slingload operations	11%	45%	22%	0%	0%	22%
Performing in-flight change of mission[c]	22%	45%	0%	11%	11%	11%
In-flight route planning	22%	33%	0%	11%	11%	22%
Threat avoidance[c]	33%	45%	0%	0%	11%	11%
Obstacle avoidance[c]	33%	33%	22%	0%	0%	11%
General Aircrew Tasks:	------	------	------	------	------	------
Monitoring aircraft status[a]	0%	56%	22%	11%	0%	11%
Radio calls[a]	0%	44%	44%	0%	0%	11%
Crew coordination[a]	11%	56%	11%	0%	0%	22%
Decision-making[a]	11%	56%	22%	0%	0%	11%
Prioritizing actions[a]	0%	45%	33%	0%	0%	22%
Manage unexpected events	11%	45%	33%	0%	0%	11%
Time to perform additional tasks	11%	45%	11%	11%	0%	22%

[a]Significant at α .05, indicating a non-random response trend.
[c]Significant at α .05 when cells for decreased workload are combined into one cell.

If you rated a task as having significantly increased or decreased workload while you used the PRISMS, describe why the level of workload was higher or lower:

Pilot Comments:

- Accurate positioning of aircraft, way points, assets, objectives and threat.
- Workload will be decreased overall by having a "no-doubt" where I am and where "they" are relevant to the picture of the A.O.
- Some of these functions are provided by a standard GPS navigation set. Integrate this system with CIS and include a moving map display.

INTENTIONALLY LEFT BLANK

APPENDIX G

SUMMARY OF PILOT RESPONSES ABOUT THE IMPACT OF PRISMS2 ON SITUATIONAL AWARENESS

INTENTIONALLY LEFT BLANK

SUMMARY OF PILOT RESPONSES ABOUT THE IMPACT OF PRISMS2 ON SITUATIONAL AWARENESS

Battlefield Element	PRISMS2 Would Significantly Increase Situation Awareness	PRISMS2 Would Moderately Increase Situation Awareness	No Difference	PRISMS2 Would Moderately Decrease Situation Awareness	PRISMS2 Would Significantly Decrease Situation Awareness	N/A
Location of ownship during the mission[a]	56%	22%	11%	0%	0%	11%
Location of friendly assets[a]	56%	22%	0%	0%	11%	11%
Location of threat[a]	56%	22%	0%	0%	11%	11%
Location of FARP[c]	45%	33%	0%	0%	11%	11%
Location of Assembly Area[c]	45%	33%	0%	0%	11%	11%
Location of ACP's[a]	56%	22%	0%	0%	11%	11%
Location of PZ's[a]	56%	22%	0%	0%	11%	11%
Location of LZ's[a]	56%	22%	0%	0%	11%	11%
Location of SP's[a]	56%	22%	0%	0%	11%	11%
Location of RP's[a]	56%	22%	0%	0%	11%	11%
Ingress Flight Route[c]	33%	45%	0%	0%	11%	11%
Egress Flight Route[c]	33%	45%	0%	0%	11%	11%
Ownship fuel status	22%	22%	33%	0%	0%	22%
Natural terrain features	22%	33%	33%	0%	0%	11%
Man-made terrain features	11%	45%	33%	0%	0%	11%

If you rated a task as having significantly increased or decreased situational awareness while you used PRISMS2, describe why the level of situational awareness was higher or lower:

Pilot Comments:

- More accurate display of aircraft movement versus pilot's finger on a hand-held map (VFR vs. IFR).
- By knowing where the battlefield elements are, it enhances my ability to concentrate on other, more pressing matters.
- Being able to have a map display with all these item locations indicated in relation to aircraft location would be great.

[a]Significant at α .05, indicating a non-random response trend.
[c]Significant at α .05 when cells for increased situation awareness are combined into one cell.

INTENTIONALLY LEFT BLANK

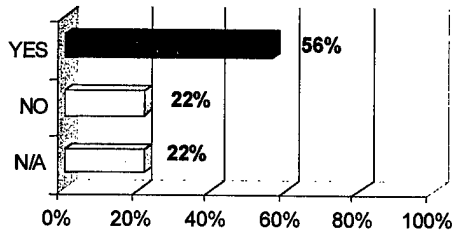
APPENDIX H

SUMMARY OF PILOT RESPONSES ABOUT HARDWARE-SOFTWARE INTERFACE CHARACTERISTICS OF PRISMS2

INTENTIONALLY LEFT BLANK

SUMMARY OF PILOT RESPONSES ABOUT HARDWARE-SOFTWARE INTERFACE CHARACTERISTICS OF PRISMS2

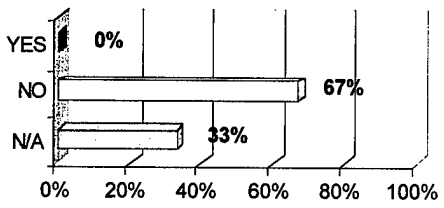
Do You Expect To Experience Problems Entering Data Into PRISMS [2]?



Pilot Comments:

- Possibly, depending on how severe vibration during flight is. Severe vibration could encumber use of keypad.
- Precision of cursor movement with a vibrating hand would be a problem.
- I would expect problems based on location and installation in cockpit, and flight vibration levels currently encountered.
- Joystick input and manipulation may be affected by vibrations and inadvertent input from a pilots checklist or something bumping up against it.
- I would expect problems with the joystick (CCG) or keypad entry method: Pilot on the controls – almost impossible during most flight environments except day, contour, non-tactical missions. Pilot not on the controls may experience problems inputting and changing information while aircraft is not stabilized. Entering data via controls on cyclic or collective may ease the burden on the pilot on the controls.
- I speculate that the CCG would be hard to work during flight.
- The CCG would be too hard to handle.
- Too many buttons.
- Pilot would have to look at the keyboard head.
- Need a larger keypad if possible.
- Mouse or touchpad will not work due to vibration. Keypad entry will work.
- Too many screen functions for entering a simple MGRS or Lat/Long waypoint. MGRS a must! Please include it.
- Will have problems using joystick, but not using buttons.

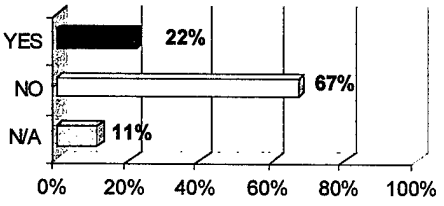
***Are There Any Hardware Features That Are Not Logical Or Consistent?**



Pilot Comments:

- Joystick will be tough to use in flight. I can't think of anything better except using the buttons.

Any Symbology On The Digital Map Display That Was Difficult To Understand Due To Size?

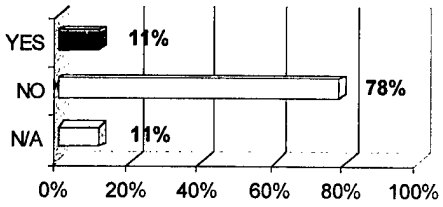


Pilot Comments:

- Airspeed and track are difficult to understand due to small size.
- Time, distance, heading track, and ground speed need to be larger for ease of reading and they need to be located in the same area. The instrument page mapping screen was difficult to read at first, but with training and time, I think it will be ok.

*Significant at α .05, indicating a non-random response trend.

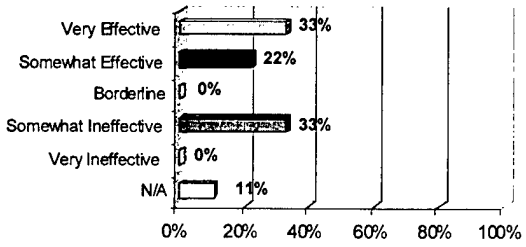
Any Symbology On The Map Or Menu Screens That Was Difficult To Understand Due To Content?



Pilot Comments:

- The symbology appeared to be standard. Limited laboratory inspection – I would expect no problems with a full course of instruction.
- The track data in the upper left corner was difficult to understand.

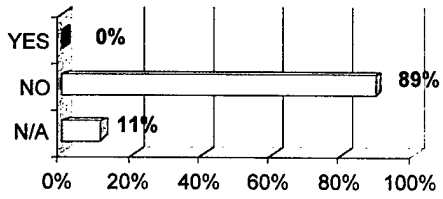
How Effective Is The Size Of The Digital Map Screen For Displaying And Entering Data?



Pilot Comments:

- The bigger display was ok. Once you increase the font size, it may become cluttered.
- The 4" X 5" MFD is too small for me. The bigger display is better.
- The large screen is very effective with the small screen being less so.
- The smaller display is too small.
- The 6" X 8" display is good. The 4" X 5" display is ineffective.
- The 6"X 8" display should be the minimum acceptable size.
- Ineffective on the 4" X 5" display. Very effective on the 6" X 8" display.

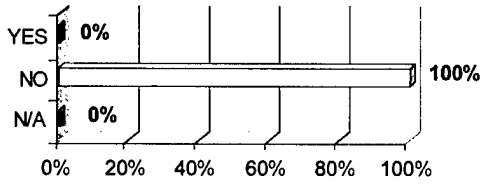
****Problems Readingand Intepreting Information Due To ReflectionsOn The Displays?**



Pilot Comments:

- Might pose a problem under goggles.

****Problems Reading and Interpreting Information On The Displays Due To Lack Of Adequate Contrast?**

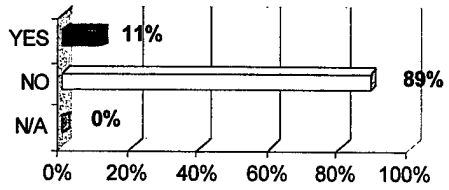


Pilot Comments:

- Under goggles, when dimmed, might be a problem.

**Significant at α .01, indicating a non-random response trend.

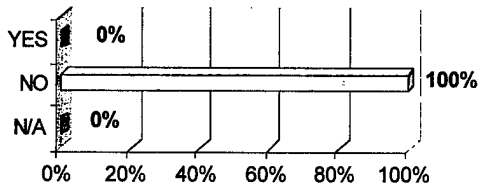
*Problems Reading and Interpreting Information On The Displays Due To Lack Of Adequate Resolution?



Pilot Comments:

- Will be a problem if display is dimmed under NVG's.
- Need a larger screen for map display to be clearly seen from both pilot stations.
- Make the font bigger.

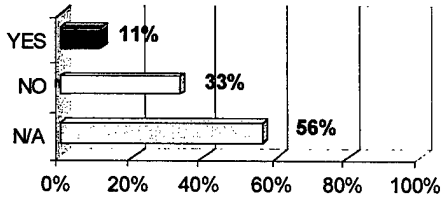
**Problems Reading and Interpreting Information On The Displays Due To Lack Of Adequate Brightness?



Pilot Comments:

- Good adjustment of brightness.
- Dimmer switch is excellent, but how would it fare under NVG conditions?
- Under goggles, the display might be too bright.

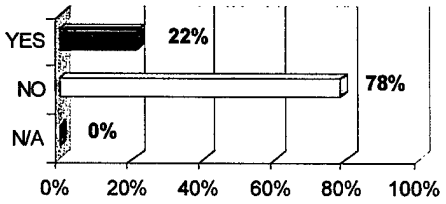
Anticipate Problems Reading and Interpreting Information On The Displays Due To Vibration?



Pilot Comments:

- Reading the display and inputting data with the CCG might be hard. I would need to experiment with the system to answer it more accurately.
- If mounted on a swivel mount, vibration may affect readability.

Problems Reading and Interpreting Information On The Displays Due To Inadequate Off-Axis Viewability?

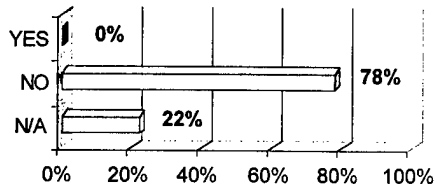


Pilot Comments:

- Assuming the display is on the center console and I have to input data, off-axis viewability would be difficult, maybe not impossible.
- Not able to read the side legend on the side where the a pilot or copilot would be sitting if the screen was in the middle of the cockpit.
- Location in actual aircraft will be critical.
- Off-axis viewability was poor. Need displays on both sides of the cockpit.

**Significant at α .01, indicating a non-random response trend.
*Significant at α .05, indicating a non-random response trend.

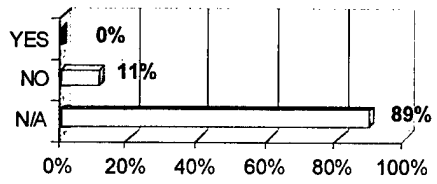
***Problems Reading and Interpreting Information On The Displays Due To Inadequate Sunlight Readability?**



Pilot Comments:

- Excellent display.

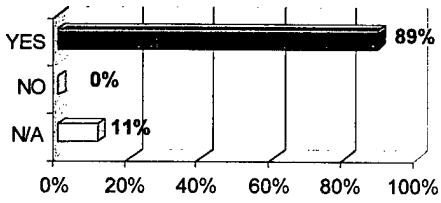
Do You Believe PRISMS [2] Would Cause Any Problems With The Use Of Night Vision Goggles?



Pilot Comments:

- Not a problem assuming the displays have NVG filtering.
- The displays should be adequately tested.

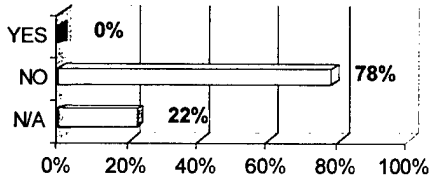
****Were The Colors Used To Display Information On The Map Appropriate?**



Pilot Comments:

- Need to make all color schemes match up to DoD flip and military symbols.

***When Entering And Retrieving Information, Are There Any Steps That Are Not Logical Or Consistent?**

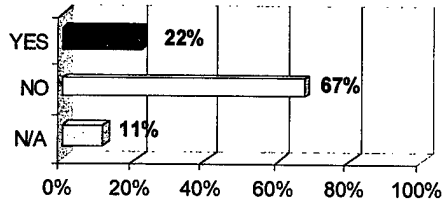


Pilot Comments:

- No significant comments.

**Significant at α .01, indicating a non-random response trend.
*Significant at α .05, indicating a non-random response trend.

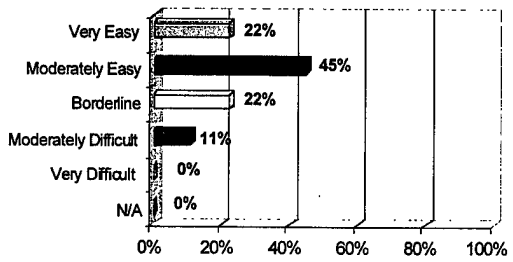
Are There Too Many Steps Required For Entering And Retrieving Information?



Pilot Comments:

- Maximum number of button pushes should be two.
- Are too many steps for entering way points or navaids.

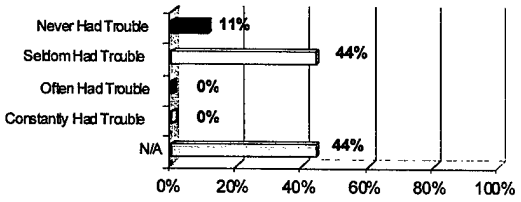
How Easy Was It To Navigate Through The Display Screens?



Pilot Comments:

- Takes specific concentration. Probable improvement with training and use of the system.
- Limited laboratory instruction. No problems expected with anticipated instruction program.
- Bezel buttons make page selection quick and easy.

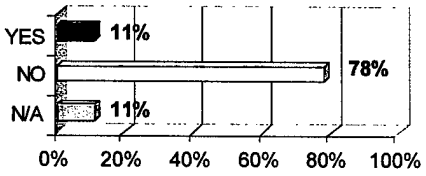
How Often Did You Have Trouble Remembering Where You Were At In The Menu Structure?



Pilot Comments:

- No significant comments.

Any Instances When The Map Display Screen Is Too Cluttered Making It Difficult To Read Or Enter Data?



Pilot Comments:

- Declutter modes are a must.
- Clutter was a problem on the small (4" X 5") MFD.
- Clutter may be a problem once the fonts are made bigger for easier readability.
- Save money on flight data and give us a centrally located MFD with full battlefield integration. If we can't afford to outfit both stations with this, just give us something we can use. FAA certification is a must!
- The flight situation display (4" X 5") was too cluttered.

What are the biggest improvements that can be made in the PRISMS2 to make it more effective for performing your mission?

Pilot Comments:

Comments regarding the software interface for PRISMS2:

- Ground speed only needs to be a 3-digit display. No need for a bar.
- Ground speed, heading, track, time to/from needs to be easily readable (big #'s) and in the same location.
- Would be nice if it were a 3-D map. It might be a big added improvement
- Need a bigger font on some of the text.
- Eliminate some redundant information like the air speed sliding scale.
- Unclutter some of the displays.
- Need a map scale smaller than 1:50,000. Maybe down to 1:10,000.
- Add more map data.
- Need a hover circle – it should be less than 50 feet in diameter (current hover standards allow no more than 3 feet of drift).
- Instead of VHF/AM, request that the display read "VHF, UHF, FM1 or FM2".
- Incorporate a turn-rate indicator on the flight display (comment from two pilots).
- Allow the ground speed indicator to be changed from knots' ground speed to kilometers' ground speed.
- Modify the heading select marker (heading bug) to be more easily adjustable.
- Need ability to zoom in to a better/smaller scale than 1:50,000.
- Provide a choice of scale and type of map.
- Design threat data on the MFD to display range fans for the type of threat being displayed to enhance flight route data and moving map displays.
- Design the display to provide "track-up data" with an orientation to north if needed or requested by the pilot.
- Design the ability to select certain way points as a flight route (sequence) and the ability to change the route at any time the pilot deems necessary.
- Incorporate the flexibility to input either MGRS or LAT/LONG data. The Air Force deals strictly with LAT/LONG.
- Incorporate the ability for the pilot to choose the way points desired to be non-corruptible or corruptible.
- Display situation awareness data with the ability to declutter or select specific information to be displayed.
- Provide external load monitoring.
- With better technology, increase database for maps and way points/navaids/aerodromes.

Comments regarding the hardware interface for PRISMS2:

- Need to make the digital map larger
- Make data input/changes as easy as turning one knob, etc. Pilot on controls has only one hand and 3 seconds to change things like "heading bug".
- Need mouse control on pilot and copilot's collective.
- Need MFD no smaller than 6" X 8" with 8" X 8" optimal. Ideally, need two MFDs with one for the pilot and one for the copilot.
- Make it easier to display information by providing two displays – one for the pilot and one for the copilot.
- Cancel the small MFD as an option. It's too small and not functional on the center console
- Need fully integrated "smart" displays on both instrument panels.
- Not MANPRINT compatible if installed on swivel on center console.
- Reduce the "recess" of the glass to the bezel of the system to enhance the visibility of all cues and displays from the right seat.

• Replace the current AN/ASN-128B keyboard (on the console) with PRISMS2 keyboard to reduce
"cockpit clutter" of two keyboards. Also, have the design flexibility to revert back to the AN/ASN-128B keyboard.
• Design the ability to input SPINS/ACO/mission data *easily* without causing data entry to be inputted in inaccessible areas of the aircraft. Install the data loader for the PRISMS2 either on the keyboard itself or on top of the keyboard.
• If one MFD is to be used or purchased for each aircraft, concentrate on navigation data (moving map, route/way point data) and don't incorporate the flight data. More memory and computer functions could be used to support a VERY GOOD navigation package. Also, have the design flexibility to revert to the current caution/advisory panel if the need arises.
• Delete instruments page.

Comments regarding location and accessibility of PRISMS2 to pilots in the cockpit:

• Mount where current caution advisory panel is and integrate –CL items when a fault it detected
• Rather than making it removable, hard mount this equipment and ensure each aircraft is upgraded. Not every mission requires a flight of 10; it's the individual missions that would require this technology.
• Determine optimal installation location, pilot/copilot access and visibility.
• A center display would allow BOTH pilots a better view from either seat.

Comments regarding integration of PRISMS2 with aircraft systems:

• Integrate PRISMS2 with present CIS and drop navigation functions. Concentrate on movement on or around the battlefield and communications!
• Try integrating PRISMS2 with existing equipment for a short-term fix.
• Need hooks to use data from current analog systems (instruments).
• Tie routes to current ability to display route following of instrumentation.
• Determine effects of power supply switching (i.e., APU generator vs. aircraft main generators) during aircraft run-up and shutdown.
• Without full integration and display on the instrument panel (to replace the electro-mechanical gauges), the PRISMS2 does not significantly improve flight tasks.
• Integrate the PRISMS2 into the caution/advisory panel to save space on the instrument panel and to display the appropriate caution/advisory segments and display the emergency procedure associated with the malfunction in the same area. Also, have the capability to use the same connectors of the current caution/advisory panel if possible to replace PRISMS2 if the need arises.
• Incorporate the ability to use PRISMS2 using DC ESS power (battery power) for input of data without using the APU (DC PRIM).

Miscellaneous comments:

• Extremely high risk, if user accepts this system for the UH-60. If the PRISMS2 is "good enough" (and it is not!), then it may become the system of choice for the L-plus and UH-60(X). The UH-60 needs a fully integrated, ORD compliant system.
• Ensure a program of instruction and operator's manual are fully developed.
• Have a system to assist pilot on controls with emergency procedures, check lists, for start-up, shutdown, mission equipment, etc.
• I should be able to plan the route on AMPS and plug it into PRISMS2 and get the same information if I'd used my prepared paper map.
• Should be able to plan a mission en route, i.e., I'm flying Col X-Ray from A to B. En route to B, my higher HQ calls to divert me to pick up CSS supplies from the BSA to 1 Bn of X Div. Grids of PZ and LZ are provided to me.
• Need IFR capability.
• Get experienced UH-60 IP's, PIC's, UT's to make this as user friendly as possible. The device I saw was designed for a customer that had his need in mind.

INTENTIONALLY LEFT BLANK

APPENDIX I

SUMMARY OF PILOT RESPONSES ABOUT THE IMPACT OF THE PEREGRINE DIGITAL MAP ON WORKLOAD

INTENTIONALLY LEFT BLANK

SUMMARY OF PILOT RESPONSES ABOUT THE IMPACT OF THE PEREGRINE DIGITAL MAP ON WORKLOAD

Tasks	Peregrine Significantly Decreased Workload	Peregrine Moderately Decreased Workload	No Difference	Peregrine Moderately Increased Workload	Peregrine Significantly Increased Workload	N/A
Flight & Navigation Tasks:	------	------	------	------	------	-----
Determine present position of aircraft[a]	80%	20%	0%	0%	0%	0%
Maintain heading	0%	40%	40%	20%	0%	0%
Maintain ground track[a]	0%	80%	20%	0%	0%	0%
Maintain altitude[a]	0%	0%	100%	0%	0%	0%
Determine time ahead-behind schedule	20%	40%	40%	0%	0%	0%
Determine distance to object	40%	20%	20%	20%	0%	0%
Way point Identification[c]	20%	60%	20%	0%	0%	0%
Identification of terrain features	0%	60%	40%	0%	0%	0%
Correlating flight display information (e.g., air speed) with digital map information vs. paper map	20%	20%	60%	0%	0%	0%
General Aircrew Tasks:	------	------	------	------	------	------
Monitoring aircraft status	20%	0%	60%	0%	0%	20%
Radio calls	0%	0%	60%	0%	0%	40%
Crew coordination	0%	20%	20%	20%	0%	40%
Decision making	0%	40%	40%	0%	0%	20%
Prioritizing actions[a]	0%	0%	80%	0%	0%	20%
Manage unexpected events	0%	40%	20%	0%	0%	40%

[a]Significant at α .05, indicating a non-random response trend.
[c]Significant at α .05 when cells for decreased workload are combined into one cell.

INTENTIONALLY LEFT BLANK

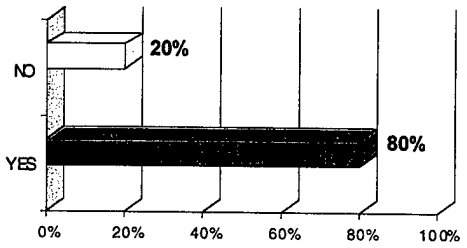
APPENDIX J

SUMMARY OF PILOT RESPONSES ABOUT HARDWARE-SOFTWARE INTERFACE CHARACTERISTICS OF THE PEREGRINE DIGITAL MAP

INTENTIONALLY LEFT BLANK

SUMMARY OF PILOT RESPONSES ABOUT HARDWARE-SOFTWARE INTERFACE CHARACTERISTICS OF THE PEREGRINE DIGITAL MAP

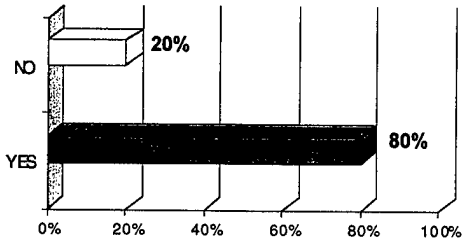
PROBLEMS ENTERING DATA INTO PEREGRINE?



Pilot Comments:

- Too many menu screens (*Comment made by two pilots)
- Hard to use pen on screen due to vibration and small screen size.
- Magnetic pen vibrates.
- Icons are too small.

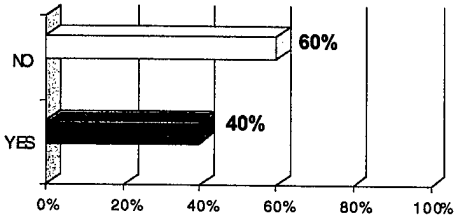
ARE THERE TOO MANY STEPS REQURED TO ENTER AND RETREVE INFORMATION?



Pilot Comments:

- Too many menu screens
- Menu screens are 4-5 deep which is too many.
- Too many steps for grid coordinates – cumbersome
- Too many steps to input waypoints.
- During flight, it requires a long time inside the cockpit to confirm proper entry of information.

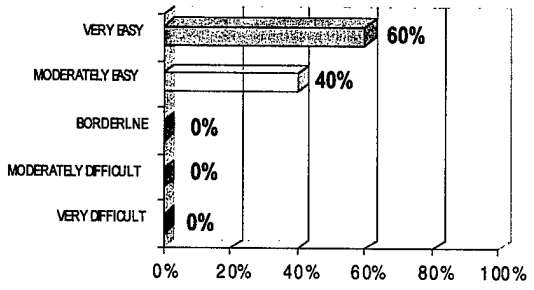
ANY STEPS FOR ENTERING/RETREVING INFORMATION THAT ARE NOT LOGICAL AND CONSISTENT?



Pilot Comments:

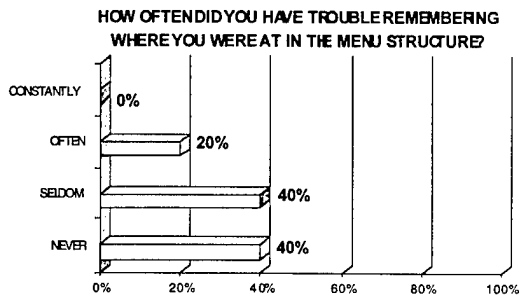
- Entering grid coordinates is cumbersome.

HOW EASY IS NAVIGATION THROUGH THE DISPLAY SCREENS?



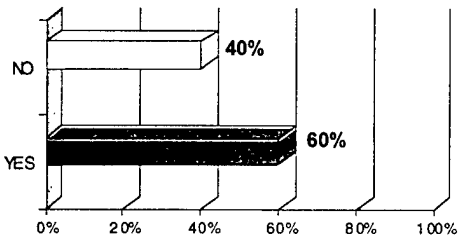
Pilot Comments:

- No significant comments.



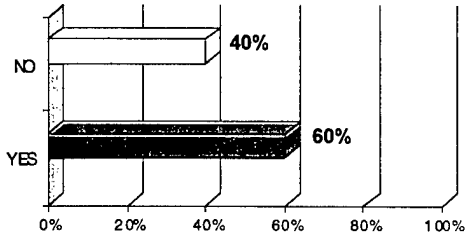
Pilot Comments:

- Often had trouble due to lack of experience with system. With more experience, this would probably not be a problem.



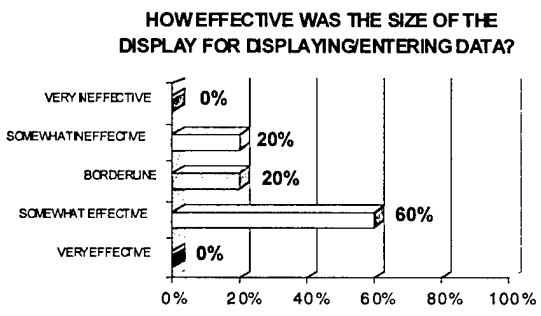
Pilot Comments:

- The map scale size screen is too cluttered. I need 1:50,000 for terrain flight and I'm limited to 3 X 4 squares and have no forward look at the upcoming terrain without it (1:50K map wasn't available to pilot).
- Only when scrolling the map.



Pilot Comments:

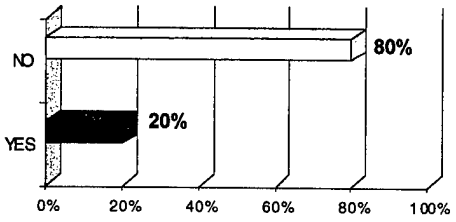
- Icons on top of screen are difficult to understand. Need look-up table that's easily accessible and gives definition of icons.
- During high vibration, information takes a couple of minutes for your brain to comprehend.
- Need MIL-STD 2525 symbology in near future.



Pilot Comments:

- Need more map scales (1:100K) for a farther look.
- Icons are easy to miss during periods of high vibrations.
- Screen is too small for 1:50K, map especially if you have a threat at 10 kilometers. Screen is o.k. for 1:250K map.

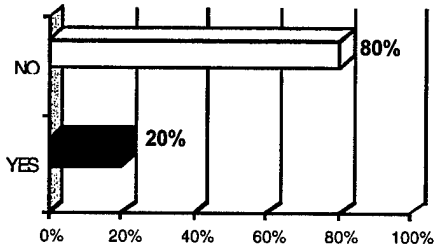
ANY PROBLEMS WITH READING & INTERPRETING INFORMATION ON DISPLAY DUE TO LACK OF RESOLUTION?



Pilot Comments:

- Sunlight washes out resolution.

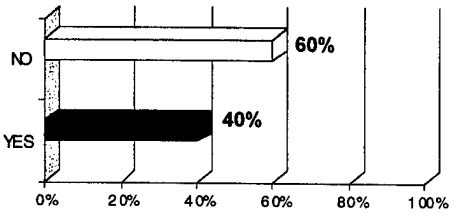
ANY PROBLEMS WITH READING & INTERPRETING INFORMATION ON DISPLAY DUE TO LACK OF CONTRAST?



Pilot Comments:

- Sunlight washes out contrast.

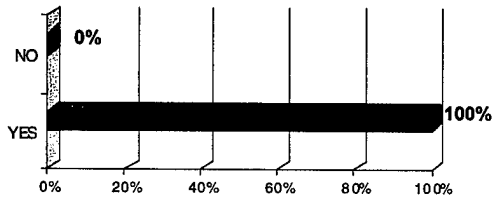
ANY PROBLEMS WITH READING & INTERPRETING INFORMATION ON DISPLAY DUE TO VIBRATION?



Pilot Comments:

- Pen vibrates (very minor).
- Screen hard to read during vibration.
- Leg and pen vibrate at different frequencies.

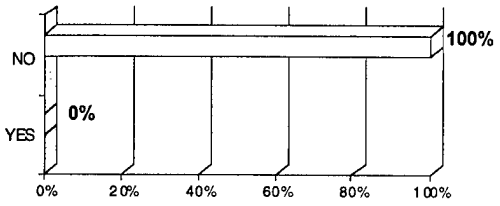
ANY PROBLEMS WITH READING & INTERPRETING INFORMATION DUE TO SUNLIGHT READABILITY OF DISPLAY?



Pilot Comments:

- Sunlight washes out screen easily*.
  (*comment made by three pilots)
- In very bright sunlight, I had to angle it away from direct sunlight.

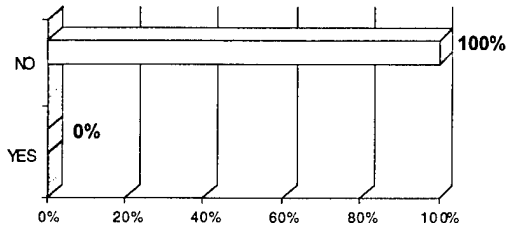
DID WEARING THE PEREGRINE CAUSE DISCOMFORT DUE TO PRESSURE POINTS, WEIGHT, STABILITY, ETC.?



Pilot Comments

- No significant comments.

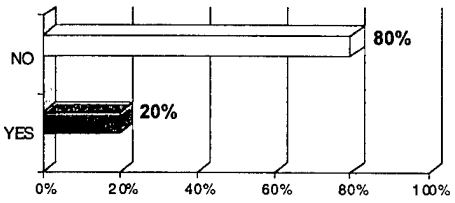
DID WEARING THE PEREGRINE INTERFERE WITH YOUR FLIGHT SUIT OR FLIGHT GEAR?



Pilot Comments

- No significant comments.

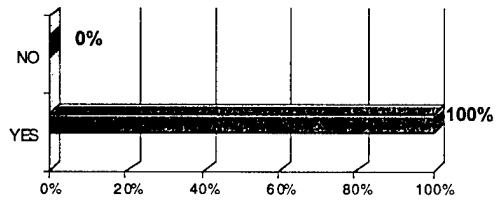
DID WEARING THE PEREGRINE INTERFERE WITH AIRCRAFT STRUCTURE (e.g., center console)?



Pilot Comments

- No significant comments.

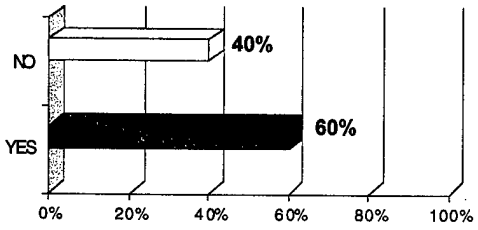
DID WEARING THE PEREGRINE INTERFERE WITH FLIGHT CONTROL (i.e., cyclic, collective) MOVEMENT?



Pilot Comments

- In the right seat on my left leg, there was some interference between the Peregrine and the cyclic & collective.
- Emergency egress would be a problem since the cannon plug is not quick-disconnect.
- Is cumbersome with leg strap. If battery weren't in leg strap, maybe it would be better.
- Too big for cyclic-collective.

ANY PROBLEMS WITH READNG & INTERPRETNG INFORMATION ON DISPLAY DUE TO OFF-AXIS VIEWABILITY?



Pilot Comments

- Can't see display well off-axis.

Pilots' responses when asked to "list the biggest improvements that could be made in the Peregrine to make it more effective for performing their mission":

- Need a digital checklist.
- Locate the system on the center console.
- Put the digital map on a multi-function display or visor. Get it off the knee.
- Need the map to point in the direction of the flight at all times.
- Routes should be bendable (curved) not straight lines from point to point. Routes should follow terrain.
- Need some kind of scratch resistant screen cover.
- Need less wires and cords.
- Reduce bulkiness of CPU display unit.
- Mission planning needs to be more user friendly.
- Eliminate GPS cable dangling from cockpit ceiling.
- Eliminate CPU display unit cable from interfering with collective.

INTENTIONALLY LEFT BLANK

NO. OF COPIES ORGANIZATION

1 ADMINISTRATOR
DEFENSE TECHNICAL INFO CTR
ATTN DTIC OCA
8725 JOHN J KINGMAN RD STE 0944
FT BELVOIR VA 22060-6218

1 DIRECTOR
US ARMY RSCH LABORATORY
ATTN AMSRL CI AI R REC MGMT
2800 POWDER MILL RD
ADELPHI MD 20783-1197

1 DIRECTOR
US ARMY RSCH LABORATORY
ATTN AMSRL CI LL TECH LIB
2800 POWDER MILL RD
ADELPHI MD 207830-1197

1 DIRECTOR
US ARMY RSCH LABORATORY
ATTN AMSRL D D SMITH
2800 POWDER MILL RD
ADELPHI MD 20783-1197

1 DIR FOR PERS TECHNOLOGIES
DPY CHIEF OF STAFF PERS
300 ARMY PENTAGON 2C733
WASHINGTON DC 20310-0300

1 OUSD(A)/DDDR&E(R&A)/E&LS
PENTAGON ROOM 3D129
WASHINGTON DC 20301-3080

1 CODE 1142PS
OFC OF NAVAL RSCH
800 N QUINCY STREET
ARLINGTON VA 22217-5000

1 WALTER REED INST OF RSCH
ATTN SGRD UWI C
COL REDMOND
WASHINGTON DC 20307-5100

1 CDR
US ARMY RSCH INST
ATTN PERI ZT DR E M JOHNSON)
5001 EISENHOWER AVENUE
ALEXANDRIA VA 22333-5600

NO. OF COPIES ORGANIZATION

1 DEF LOGISTICS STUDIES
INFORMATION EXCHANGE
ATTN DIR DLSIE ATSZ DL
BLDG 12500
2401 QUARTERS ROAD
FORT LEE VA 23801-1705

1 DPY COMMANDING GENERAL
ATTN EXS (Q)
MARINE CORPS RD&A COMMAND
QUANTICO VA 22134

1 HEADQUARTERS USATRADOC
ATTN ATCD SP
FORT MONROE VA 23651

1 CDR
USATRADOC
COMMAND SAFETY OFC
ATTN ATOS MR PESSAGNO/MR LYNE
FORT MONROE VA 23651-5000

1 DIRECTOR TDAD DCST
ATTN ATTG C
BLDG 161
FORT MONROE VA 23651-5000

1 HQ USAMRDC
ATTN SGRD PLC
FORT DETRICK MD 21701

1 CDR
USA AEROMEDICAL RSCH LAB
ATTN LIBRARY
FORT RUCKER AL 36362-5292

1 US ARMY SAFETY CTR
ATTN CSSC SE
FORT RUCKER AL 36362

1 CHIEF
ARMY RSCH INST
AVIATION R&D ACTIVITY
ATTN PERI IR
FORT RUCKER AL 36362-5354

1 AIR FORCE FLIGHT DYNAMICS LAB
ATTN AFWAL/FIES/SURVIAC
WRIGHT PATTERSON AFB OH 45433

NO. OF COPIES	ORGANIZATION
1	US ARMY NATICK RD&E CTR ATTN STRNC YBA NATICK MA 01760-5020
1	US ARMY TROOP SUPPORT CMD NATICK RD&E CTR ATTN BEHAVIORAL SCI DIV SSD NATICK MA 01760-5020
1	US ARMY TROOP SUPPORT CMD NATICK RD&E CTR ATTN TECH LIB (STRNC MIL) NATICK MA 01760-5040
1	DR RICHARD JOHNSON HEALTH & PERFORMANCE DIV US ARIEM NATICK MA 01760-5007
1	NAVAL SUB MED RSCH LAB MEDICAL LIB BLDG 148 BOX 900 SUBMARINE BASE NEW LONDON GROTON CT 06340
1	USAF ARMSTRONG LAB/CFTO ATTN DR F W BAUMGARDNER SUSTAINED OPERATIONS BR BROOKS AFB TX 78235-5000
1	CDR USAMC LOGISTICS SUP ACTIVITY ATTN AMXLS AE REDSTONE ARSENAL AL 35898-7466
1	ARI FIELD UNIT FT KNOX BLDG 2423 PERI IK FORT KNOX KY 40121-5620
1	COMMANDANT USA ARTY & MISSILE SCHOOL ATTN USAAMS TECH LIB FORT SILL OK 73503
1	CDR WHITE SANDS MISSILE RANGE ATTN STEWS TE RE WSMR NM 88002

NO. OF COPIES	ORGANIZATION
1	CDR WHITE SANDS MISSILE RANGE ATTN TECHNICAL LIBRARY WSMR NM 88002
1	USA TRADOC ANALYSIS CMD ATTN ATRC WSR D ANGUIANO WSMR NM 88002-5502
1	STRICOM 12350 RSCH PARKWAY ORLANDO FL 32826-3276
1	CDR USA COLD REGIONS TEST CTR ATTN STECR TS A APO AP 96508-7850
1	PURDUE UNIVERSITY SERIALS UNIT CDM KARDEX 1535 STEWART CTR WEST LAFAYETTE IN 47907-1535
1	GOVT PUBLICATIONS LIB 409 WILSON M UNIVERSITY OF MINNESOTA MINNEAPOLIS MN 55455
1	DR RICHARD PEW BBN SYSTEMS &TECH CORP 10 MOULTON STREET CAMBRIDGE MA 02138
1	DR HARVEY A TAUB RSCH SECTION PSYCH SECTION VETERANS ADMIN HOSPITAL IRVING AVE & UNIVERSITY PLACE SYRACUSE NY 13210
1	DR ROBERT C SUGARMAN 132 SEABROOK DRIVE BUFFALO NY 14221
1	DR ANTHONY DEBONS IDIS UNIV OF PITTSBURGH PITTSBURGH PA 15260

NO. OF COPIES	ORGANIZATION
1	MR R BEGGS BOEING-HELICOPTER CO P30-18 PO BOX 16858 PHILADELPHIA PA 19142
1	DR ROBERT KENNEDY ESSEX CORPORATION STE 227 1040 WOODCOCK ROAD ORLANDO FL 32803
1	DR NANCY ANDERSON DEPT OF PSYCHOLOGY UNIVERSITY OF MARYLAND COLLEGE PARK MD 20742
1	DR BEN B MORGAN DEPT OF PSYCHOLOGY UNIV OF CENTRAL FLORIDA PO BOX 25000 ORLANDO FL 32816
1	LAWRENCE C PERLMUTER PHD UNIV OF HEALTH SCIENCES THE CHICAGO MEDICAL SCHOOL DEPT OF PSYCHOLOGY 3333 GREEN BAY ROAD NORTH CHICAGO IL 60064
1	GMC N AMER OPERATIONS PORTFOLIO ENGINEERING CTR HUMAN FACTORS ENGINEERING ATTN MR A J ARNOLD STAFF PROJ ENG ENGINEERING BLDG 30200 MOUND RD BOX 9010 WARREN MI 48090-9010
1	GENERAL DYNAMICS LAND SYSTEMS DIV LIBRARY PO BOX 1901 WARREN MI 48090
1	DR LLOYD A AVANT DEPT OF PSYCHOLOGY IOWA STATE UNIVERSITY AMES IA 50010
1	DR MM AYOUB DIRECTOR INST FOR ERGONOMICS RSCH TEXAS TECH UNIVERSITY LUBBOCK TX 79409

NO. OF COPIES	ORGANIZATION
1	DELCO DEF SYS OPERATIONS ATTN RACHEL GONZALES B204 7410 HOLLISTER AVE GOLETA CA 93117-2583
1	MR WALT TRUSZKOWSKI NASA/GODDARD SPACE FLIGHT CTR CODE 588.0 GREENBELT MD 20771
1	US ARMY ATTN AVA GEDDES MS YA:219-1 MOFFETT FIELD CA 94035-1000
1	DR NORMAN BADLER DEPT OF COMPUTER & INFO SCIENCE UNIV OF PENNSYLVANIA PHILADELPHIA PA 19104-6389
1	CDR US ARMY RSCH INST OF ENVIRONMNTL MEDICINE NATICK MA 01760-5007
1	HQDA (DAPE ZXO) ATTN DR FISCHL WASHINGTON DC 20310-0300
1	HUMAN FACTORS ENG PROGRAM DEPT OF BIOMEDICAL ENGNG COLLEGE OF ENGINEERING & COMPUTER SCIENCE WRIGHT STATE UNIVERSITY DAYTON OH 45435
1	CDR USA MEDICAL R&D COMMAND ATTN SGRD PLC LTC K FRIEDL FORT DETRICK MD 21701-5012
1	PEO ARMORED SYS MODERNIZATION US ARMY TANK-AUTOMOTIVE CMD ATTN SFAE ASM S WARREN MI 48397-5000
1	PEO COMMUNICATIONS ATTN SFAE CM RE FT MONMOUTH NJ 07703-5000

NO. OF COPIES ORGANIZATION

1 PEO AIR DEF
ATTN SFAE AD S
US ARMY MISSILE COMMAND
REDSTONE ARSENAL AL
35898-5750

1 PEO STRATEGIC DEF
PO BOX 15280 ATTN DASD ZA
US ARMY STRATEGIC DEF CMD
ARLINGTON VA 22215-0280

1 PROGRAM MANAGER RAH-66
ATTN SFAE AV
BLDG 5300 SPARKMAN CTR
REDSTONE ARSENAL AL 35898

1 JON TATRO
HUMAN FACTORS SYS DESIGN
BELL HELICOPTER TEXTRON INC
PO BOX 482 MAIL STOP 6
FT WORTH TX 76101

1 CHIEF CREW SYS INTEGRATION
SIKORSKY AIRCRAFT M/S S3258
NORTH MAIN STREET
STRATFORD CT 06602

1 GENERAL ELECTRIC COMPANY
ARMAMENT SYS DEPT RM 1309
ATTN HF/MANPRINT R C MCLANE
LAKESIDE AVENUE
BURLINGTON VT 05401-4985

1 JOHN B SHAFER
250 MAIN STREET
OWEGO NY 13827

1 OASD (FM&P)
WASHINGTON DC 20301-4000

1 COMMANDANT
US ARMY ARMOR SCHOOL
ATTN ATSB CDS MR LIPSCOMB
FT KNOX KY 40121-5215

1 CDR
US ARMY SIGNAL CTR &
FT GORDON
ATTN ATZH CDM
FT GORDON GA 30905-5090

NO. OF COPIES ORGANIZATION

1 DIRECTOR
US ARMY AEROFLIGHT
DYNAMICS DIR
MAIL STOP 239-9
NASA AMES RSCH CTR
MOFFETT FIELD CA 94035-1000

1 CDR
MARINE CORPS SYSTEMS CMD
ATTN CBGT
QUANTICO VA 22134-5080

1 DIR AMC-FIELD ASSIST IN
SCIENCE & TECHNOLOGY
ATTN AMC-FAST
FT BELVOIR VA 22060-5606

1 CDR
US ARMY FORCES CMD
ATTN FCDJ SA BLDG 600
AMC FAST SCIENCE ADVISER
FT MCPHERSON GA 30330-6000

1 CDR
I CORPS AND FORT LEWIS
AMC FAST SCIENCE ADVISER
ATTN AFZH CSS
FORT LEWIS WA 98433-5000

1 HQ III CORPS & FORT HOOD
OFC OF THE SCIENCE ADVISER
ATTN AFZF CS SA
FORT HOOD TX 76544-5056

1 CDR
HQ XVIII ABN CORPS & FT BRAGG
OFC OF THE SCI ADV BLDG 1-1621
ATTN AFZA GD FAST
FORT BRAGG NC 28307-5000

1 SOUTHCOM WASHINGTON
FIELD OFC
1919 SOUTH EADS ST STE L09
AMC FAST SCIENCE ADVISER
ARLINGTON VA 22202

1 HQ US SPECIAL OPERATIONS CMD
AMC FAST SCIENCE ADVISER
ATTN SOSD
MACDILL AIR FORCE BASE
TAMPA FL 33608-0442

NO. OF COPIES	ORGANIZATION
1	HQ US ARMY EUROPE AND 7TH ARMY ATTN AEAGX SA OFC OF THE SCIENCE ADVISER APO AE 09014
1	CDR HQ 21ST THEATER ARMY AREA CMD AMC FAST SCIENCE ADVISER ATTN AERSA APO AE 09263
1	CDR HEADQUARTERS USEUCOM AMC FAST SCIENCE ADVISER UNIT 30400 BOX 138 APO AE 09128
1	HQ 7TH ARMY TRAINING CMD UNIT #28130 AMC FAST SCIENCE ADVISER ATTN AETT SA APO AE 09114
1	CDR HHC SOUTHERN EUROPEAN TASK FORCE ATTN AESE SA BLDG 98 AMC FAST SCIENCE ADVISER APO AE 09630
1	CDR US ARMY PACIFIC AMC FAST SCIENCE ADVISER ATTN APSA FT SHAFTER HI 96858-5L00
1	AMC FAST SCIENCE ADVISERS PCS #303 BOX 45 CS-SO APO AP 96204-0045
1	MS DIANE UNGVARSKY HHC 2BDE 1AD UNIT 23704 APO AE 09034
1	ENGINEERING PSYCH LAB DEPT OF BEHAVIORAL SCIENCES & LEADERSHIP BLDG 601 ROOM 281 US MILITARY ACADEMY WEST POINT NY 10996-1784

NO. OF COPIES	ORGANIZATION
1	DIR SANDIA NATL LAB ENGNRNG MECHANICS DEPT MS 9042 ATTN J HANDROCK Y R KAN J LAUFFER PO BOX 969 LIVERMORE CA 94551-0969
1	DR SEHCHANG HAH WM J HUGHES TECH CTR FAA NAS HUMAN FACTORS BR ACT-530 BLDG 28 ATLANTIC CITY INTNATL AIRPORT NJ 08405
1	US ARMY RSCH INST ATTN PERI IK D L FINLEY 2423 MORANDE STREET FORT KNOX KY 40121-5620
1	NAIC/DXLA 4180 WATSON WAY WRIGHT PATTERSON AFB OH 45433-5648
10	ARL HRED AVNC FLD ELMT ATTN AMSRL HR MJ D DURBIN PO BOX 620716 BLDG 514 FT RUCKER AL 36362-0716
1	ARL HRED AMCOM FLD ELMT ATTN AMSRL HR MI D FRANCIS BUILDING 5678 ROOM S13 REDSTONE ARSENAL AL 35898-5000
1	ARL HRED AMCOM FLD ELMT ATTN ATTN AMSRL HR MO T COOK BLDG 5400 RM C242 REDSTONE ARS AL 35898-7290
1	ARL HRED USAADASCH FLD ELMT ATTN AMSRL HR ME K REYNOLDS ATTN ATSA CD 5800 CARTER ROAD FORT BLISS TX 79916-3802
1	ARL HRED ARDEC FLD ELMT ATTN AMSRL HR MG (R SPINE) BUILDING 333 PICATINNY ARSENAL NJ 07806-5000

NO. OF COPIES ORGANIZATION

1 ARL HRED ARMC FLD ELMT
ATTN AMSRL HR MH (C BIRD)
BLDG 1002 ROOM 206B
FT KNOX KY 40121

1 ARL HRED CECOM FLD ELMT
ATTN AMSRL HR ML J MARTIN
MYER CENTER RM 2D311
FT MONMOUTH NJ 07703-5630

1 ARL HRED FT BELVOIR FLD ELMT
ATTN AMSRL HR MK P SCHOOL
10170 BEACH ROAD ROOM 12
FORT BELVOIR VA 22060-5800

1 ARL HRED FT HOOD FLD ELMT
ATTN AMSRL HR MV HQ USAOTC
E SMOOTZ
91012 STATION AVE ROOM 111
FT HOOD TX 76544-5073

1 ARL HRED FT HUACHUCA
FIELD ELEMENT
ATTN AMSRL HR MY M BARNES
GREELY HALL BLDG 61801 RM 2631
FT HUACHUCA AZ 85613-5000

1 ARL HRED FLW FLD ELMT
ATTN AMSRL HR MZ A DAVISON
3200 ENGINEER LOOP STE 166
FT LEONARD WOOD MO 65473-8929

1 ARL HRED NATICK FLD ELMT
ATTN AMSRL HR MQ M R FLETCHER
NATICK SOLDIER CTR BLDG 3 RM 341
AMSSB RSS E
NATICK MA 01760-5020

1 ARL HRED OPTEC FLD ELMT
ATTN AMSRL HR MR M HOWELL
ATEC CSTE OM
PARK CENTER IV RM 1040
4501 FORD AVENUE
ALEXANDRIA VA 22302-1458

1 ARL HRED SC&FG FLD ELMT
ATTN AMSRL HR MS C MANASCO
SIGNAL TOWERS RM 303A
FORT GORDON GA 30905-5233

NO. OF COPIES ORGANIZATION

1 ARL HRED STRICOM FLD ELMT
ATTN AMSRL HR MT A GALBAVY
12350 RESEARCH PARKWAY
ORLANDO FL 32826-3276

1 ARL HRED TACOM FLD ELMT
ATTN AMSRL HR MU
M SINGAPORE
BLDG 200A 2ND FLOOR
WARREN MI 48397-5000

1 ARL HRED USAFAS FLD ELMT
ATTN AMSRL HR MF L PIERCE
BLDG 3040 RM 220
FORT SILL OK 73503-5600

1 ARL HRED USAIC FLD ELMT
ATTN AMSRL HR MW E REDDEN
BLDG 4 ROOM 332
FT BENNING GA 31905-5400

1 ARL HRED USASOC FLD ELMT
ATTN AMSRL HR MN F MALKIN
HQ USASOC BLDG E2929
FORT BRAGG NC 28310-5000

1 ARL HRED HFID FLD ELMT
ATTN AMSRL HR MP
DIANE UNGVARSKY
C/O BATTLE CMD BATTLE LAB
415 SHERMAN AVE UNIT 3
FT LEAVENWORTH KS 66027-2326

1 CDR AMC - FAST
JRTC & FORT POLK
ATTN AFZX GT DR J AINSWORTH
CMD SCIENCE ADVISOR G3
FORT POLK LA 71459-5355

ABERDEEN PROVING GROUND

2 DIRECTOR
US ARMY RSCH LABORATORY
ATTN AMSRL CI LP (TECH LIB)
BLDG 305 APG AA

1 LIBRARY
ARL BLDG 459
APG-AA

NO. OF
COPIES ORGANIZATION

1 US ATEC
RYAN BLDG
APG-AA

1 ARL HRED ECBC FLD ELMT
ATTN AMSRL HR MM R MCMAHON
BLDG 459
APG-AA

ABSTRACT ONLY

1 DIRECTOR
US ARMY RSCH LABORATORY
ATTN AMSRL CI AP TECH PUB BR
2800 POWDER MILL RD
ADELPHI MD 20783-1197

INTENTIONALLY LEFT BLANK

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	December 2000	Final

4. TITLE AND SUBTITLE

Abbreviated Assessment of Three Moving Map Displays for the UH-60 Helicopter

5. FUNDING NUMBERS

AMS Code 622716
Project No. AH70

6. AUTHOR(S)

Durbin, D.B.; Armstrong, R.N. (both of ARL)

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

U.S. Army Research Laboratory
Human Research & Engineering Directorate
Aberdeen Proving Ground, MD 21005-5425

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

U.S. Army Research Laboratory
Human Research & Engineering Directorate
Aberdeen Proving Ground, MD 21005-5425

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

ARL-TN-174

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

An assessment of three moving map display systems was conducted to support modernization of the UH-60 helicopter. The systems included the Peregrine digital map, Appliqué V2 computer and Force XXI Battle Command–Brigade and Below (FBCB2) software, and the Primary Selectable Mission Support System (PRISMS22). The assessment was based on subjective ratings by Army pilots regarding the impact of the moving map displays on aircrew workload and situational awareness when these displays are used in the cockpit for pilotage, navigation, and mission tasks. The pilots also assessed the hardware and software usability characteristics of the displays. Results indicate that each system has potential for enhancing situational awareness and minimizing workload for UH-60 pilots. However, significant improvements in the hardware and software interface of the Appliqué-FBCB2 and Peregrine digital map would need to occur before they would be suitable for use in the UH-60 cockpit. Improvements in the hardware and software interface of the PRISMS22 would enhance its usability in the cockpit. Each of the systems would also need to be fully interoperable with the Aviation Mission Planning System.

14. SUBJECT TERMS

Army aviation
moving map display
situational awareness
UH-60 helicopter
workload

15. NUMBER OF PAGES
93

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	